EPI WATER

Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

Review of the Assessment Framework and Toolbox

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Executive Summary

Participants in the EPI-WATER research consortium will show how Economic Policy Instruments (EPIs) succeed or fail in directing water resources to uses that reflect social value and priorities. The project, which runs from January 2011 to December 2013, uses a multi-faceted Assessment Framework (AF) to make ex-post evaluations of existing EPIs that have been operating in Europe and abroad and make ex-ante evaluations of potential EPIs that may be implemented within Europe.

EPIs use different "delivery mechanisms" to reach objectives. EPIs can spur behavioural change through incentives or disincentives; change conditions to enable economic transactions, or reduce risk. EPIs can be used as complements or substitutes to existing regulatory or voluntary methods of managing water quality and water flows. EPIs often use price or market mechanisms to change incentives and/or increase the range of potential actions. An EPI aimed at groundwater depletion, for example, might impose a tax on extractions. An EPI aimed at reducing the potential harm from floods may require insurance against flood damage. The variety of EPIs means that the AF needs to be flexible enough to accommodate particular EPIs but specific enough to allow side-by-side comparisons of these EPIs.

It is difficult to find an objective and widely-accepted measure of EPI performance. Some people focus on environmental outcomes (e.g., water quality); others are interested in social impacts (e.g., the incidence of higher prices for domestic water use); still others concentrate on economic efficiency (e.g., the value of crops grown with a water market). The AF is used to clarify (and where possible, quantify) the effectiveness of each EPI according to seven criteria: environmental outcomes, economic outcomes, distribution effects, institutional background, policy implementation, transaction costs, and uncertainty. Each criterion is described in terms of one or more indicators appropriate to the EPI under consideration. (The methodological toolbox that is part of this deliverable describes indicators and their assessment.)

Participants in EPI-WATER have produced 30 case studies to facilitate the understanding and operation of EPIs targeted at improving water management. The AF makes it easier to describe EPIs in a thorough, rigorous and coherent manner. Decision makers and stakeholders can then debate and implement EPIs appropriate to their local situations and needs.

Part I of this report gives an overview of the purpose of EPI-WATER. Part II reviews the performance of AF given our experience in using it for ex-post reviews of existing EPIs in Europe and beyond. Parts III and IV contain a revised AF that reflects our experiences and learning from using the AF. We will use this AF for the next phase of EPI-WATER, WP4 ex-ante assessments of several EPIs that have the potential to improve water management in Europe.

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PART I -- Overview

Clean, fresh water is essential to life, but EU governments have struggled to reverse habits and rules dating from the Industrial Revolution in which water diversions and pollution were acceptable as a means of promoting economic growth. Rivers that transported waste to the sea affected biodiversity, harmed human health, and polluted coastal and marine waters. Depleted and polluted groundwater reduced the quantity of water available in droughts and the quality of water we use for drinking and food production. Reduced river flows harm ecosystems, increase risk among agricultural producers and lower hydroelectric power generation. Channelization increases flood risk, reduces land fertility, and threatens biodiversity. These impacts vary from place to place but they directly and indirectly reduce our quality of life.

In addition, climate-change induced alteration of rainfall patterns (form, intensity and timing of rainfall) will have significant effects on water availability and frequency of extreme events such as floods and droughts. The knock-on effects of these changes will affect almost all communities throughout the EU and most economic sectors. It is not surprising thus that water becomes a centrepiece of climate adaptation initiatives. The European Union has taken several policy actions, namely:

- The European Water Framework Directive (WFD) aims to protect EU ground- and surface waters and its depending ecosystems following natural geographical and hydrological units - instead of according to administrative or political boundaries.
- The European Marine Strategy Framework Directive (MSFD) expands the ideas of the WFD to Europe’s marine waters
- Directive 2007/60/EC on the assessment and management of flood risks entered into force on 26 November 2007. This Directive now requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk.
- In order to address the issue of water scarcity and droughts the Commission presented an initial set of policy options to increase water efficiency and water savings in a Communication from the Commission to the European Parliament and the Council - Addressing the challenge of water scarcity and droughts in the European Union (COM/2007/0414 final) - published in July 2007.

EPIs for managing water resources

Economic Policy Instruments (EPIs) can make water allocation more efficient, water supply more reliable, and water-related risks easier to manage. EPIs can include environmental constraints and objectives with these human uses, and they can do so in a cost-effective manner. These "magical results" do not just happen – they are the result of careful planning, customization and implementation of EPIs best suited to local circumstances, culture and objectives.

Article 9 of the WFD discusses water pricing and cost-recovery EPIs. The water scarcity and droughts initiative emphasises EPIs in its recognition of the importance of incentive pricing for adapting water demands and ensuring sustainable water management. These promising mentions have not, however, resulted in widespread use of EPIs in reaching the environmental objectives of the WFD or water pricing. Furthermore, EPI other than water tariffs, water charges and taxes have rarely been considered so far in designing the WFD programmes of measures. Very recently, because of the very high costs of the WFD programmes of measures, some Member States have however shown renewed interest in EPIs that may be used to generate revenue, reduce water scarcity, improve water quality, manage risk and improve ecosystems.

EPIs can play an important role in complementing regulatory and voluntary instruments designed to reach environmental objectives in a cost-effective and efficient manner (according to the cultural and social dimensions of the different regions and basins).

Water as an economic good

Water is an economic asset that might be managed efficiently and sustainably (Hanemann, 2006; Rogers, et al., 2002; Serageldin, 1995; Winpenny, 1994, Young and Haveman, 1993), but water allocation has not often been determined by economic criteria. Policies for managing water have aimed at services that are either essential for life or strategic for the economy. Water policy has been almost exclusively oriented to guarantee the public provision of water services at subsidized prices. This is why water agencies and water users have been insulated from the influence of market forces (Dinar, 2000; Young, 2005). In such a frame, instead of leading to higher prices that reduce demand and encourage greater efficiency in the multiple uses of water, the limited capacity to support water resource abstraction and discharge have led to a growing demand for major infrastructure and increased public support to put increasing amounts of water services available to users, worsening shortages and deepening the water crisis (Dinar and Subramanian, 1997; Dinar et al., 2005).

These systems for human water uses have additional impacts on the ecosystems that regulate the hydrological cycle (such as forests, water sources, riparian ecosystems, soils, floodplains, lagoons, deltas, etc.) and the natural flows that deliver water services to the economy (Young and Haveman, 1993; Winpenny, 1994). Most of the time, the impacts of unpriced (or unmanaged) water uses have negative impacts on ecosystems, environmental waters, and natural resource assets (from fisheries to forests) whose property rights are not always clear or allocated in markets (Brown, 2000).

PART II – Assessment Framework Performance

1. Applying Lessons from WP3 to WP4

1.1 Overview

This section discusses the performance of the AF when we used it to evaluate EPIs within the case studies. Case studies were assessed according to seven criteria (environmental outcomes, transaction costs, etc.) that manifested in different forms for different cases. Authors attempted to identify appropriate "indicators" for each of these criteria and compare indicators to a relevant counterfactual (or baseline) to evaluate EPI performance.

The variety of indicators and case studies makes it difficult to make comparisons among case studies, even when they used similar EPIs or addressed similar problems. Even more difficult is the task of aggregating or reconciling indicators from different criteria into some "bottom line" parameter for one case study that could be compared to other case studies.

The difficulty in identifying an objective and non-objectionable metric for reconciling indicators does not mean that people will not try, but the EPI-WATER team chose to leave that task to individual readers. This is not because we have not thought of interesting ways of assembling indicators, that we do not see the tradeoffs among criteria, or that we cannot write down a summation formula for indicators. It's because every EPI participant could produce a feasible and defendable mechanism. It's the same with readers of case studies.

Rather, our task was to make as much information available as possible to readers, to allow them to reflect on how each EPI performed according to the same set of criteria. We did attempted neither to identify the most important criterion for an EPI nor to exclude criteria which the EPI addresses poorly. We merely sought to set out a clear and complete case for the reader to weigh and understand according to his own needs, values and experience. We hope that readers will keep these thoughts in mind and recommend reading a case study in its entirety before evaluating an EPI's performance.

We first describe how well the AF performed with respect to individual criteria, to understand how and why differences emerged between what we thought we would be able to say for each criterion and what we were actually able to say. We then look at the overall performance of the assessment exercise against our goal of explaining EPI performance relative to a baseline case (or counterfactual) of the outcome in the absence of the EPI. Most of our difficulties can be traced to the difficulty of understanding – and quantifying -- what would have happened in the absence of the EPI. This problem need not affect WP4 ex-ante case studies, since it may be possible to find credible baseline scenarios at the same time as we track results when the EPI is implemented.

1.2 Task performance

The case studies demonstrate that whilst all indicators might not be relevant to every case study, going beyond the traditionally measured economic and environmental impacts is important to fully understand the full range of factors that play a role in the effectiveness of the EPI.

Environmental outcomes

The uneven results of the application of the AF to environmental outcomes is partially explained by real differences in the design and the purpose of the EPIs. Only a few of the case studies (e.g., 5, 11 and 13) provide strong incentives to change behaviour. Other assessed EPIs did not provide strong incentives to change economic behaviour, even if they played an important role: instruments aimed at raising revenues , for example, are an important component in the policy mix that includes command and control mechanisms that affect water management.

Some instruments are ineffective at changing behaviour. Different effluent levies (6, 11 and 14) promised to change behaviour but did not. They were more effective at generating revenues that could be applied to treating wastewater or improving water quality. Other instruments provided information on monitoring, enforcement, and other transaction costs that could be used for future implementation of real EPIs. For example, metering water in the UK (CS12) can become a real EPI when there is an incentive (reduction in the water bill as a reward for lower consumption) for the voluntary installation of a meter.

Other instruments designed to promote a water-intensive economic activity (promotion of hydropower -- CS 15 and 17 – or reallocating regenerated water CS 10) must be compatible with the protection of water sources and meeting WFD objectives if they are to be considered an EPI. This compatibility was not included in the existing assessment.

The success or failure of EPIs often depends on its delivery mechanism and the impact of the EPI in a policy mix -- with overlapping and sometimes conflicting -- forces. Its impact can often be seen in the "tension" between public good concerns and private interests, even if this tension is sometimes overwhelmed by other elements in the mix.

Economic assessment criteria

While the coverage and consistency of the AF was generally satisfactory for the economic criteria, several difficulties arose in the detailed application of the assessment framework ex-post. This includes conceptual issues in identifying proper counterfactuals and in disentangling the EPI effects from the contextual changes. In addition, the variety of EPIs and scales revealed the standardized framework to be too broad to use.

Some criteria were only relevant for a subset of cases, e.g. risk was most important for water quantity regulation and hydropower. In other cases, there was not enough information available. In most cases this was simply due to lack of studies, also, very likely, some criteria were not documented due to lack of relevance for the specific case. Compared to the EU cases, most cases outside the EU had better descriptions of alternatives, ex post performance, and cost effectiveness.

A clear economic assessment is almost impossible if regular information collection is not provided. At the same time, policy evaluation is largely a matter of proper conceptualization – the addition of some basic information may not assist in a comprehensive and meaningful evaluation.

Enhanced measurement of distributional effects

The complexity of economic, environmental, political and other factors mixed with various stakeholder interests can make it particularly challenging to assess the social and distributional impacts of EPI. The range of positive and negative results in the case studies reveals the complexity in implementing an EPI. The most effective way to disentangle these complexities and understand the effects of the EPI is to consider the impacts on each stakeholder group for each indicator.

Without historic and stakeholder data, it is vital to be realistic when allocating resources towards completing this task. The results of the application of the assessment framework have highlighted that stakeholder interviews are almost always required to reveal the full impacts of an EPI.

Going forward, we have amended the AF to make the the grid more familiar to stakeholders. We also recommend committing more time (and planning) to interviewing stakeholders.

Institutions

In most case studies, the description of institutions gave readers a decent understanding of the forces that affected the design, implementation and operation of the EPI. In some cases, the description of institutions – akin to telling stories or recounting histories replete with heroes and villains – did not bring useful information to readers. This failure can be attributed to under-investment in understanding exogenous factors affecting the EPI, a failure to trace the evolution of the EPI, and/or a mistaken belief that "institution" is the same as "organization" or "law." Institutions – like one's family at a wedding – express dynamic interactions that integrate past events, present constraints, and future hopes. They may be informal or tacit, but their impact cannot be underestimated.

Readers interested in applying lessons learned from these case studies to their own water problems should compare and contrast the institutions of these case studies to their local institutions. A clear understanding of the differences can allow for adaptations; a mistaken understanding can produce adverse, unexpected impacts.

Policy implementability

Our in-depth assessment showed that the assessment framework needed some minor updates to facilitate the assessment of policy implementability. We deleted two sub-questions that were irrelevant to most case studies, merged two sub-questions into other questions to address data limitations and clarify the assessment structure.

Transaction costs

Although few authors took the time to give a detailed description of the TCs related to the design, implementation and operation of EPIs – let alone quantify those costs – there is no reason to reduce or simplify the task description in the AF. The existence, magnitude and distribution of TCs can mean the difference between success and failure of an EPI on an individual or social scale.

In the future, we recommend that authors spend more time "in the shoes" of someone charged with implementing and operating an EPI and a user of that EPI. Such a change of perspective – combined with a detailed list of who does what and pays what (and when) – would make it easier to understand how large benefits must be to overcome these costs. (It's harder to quantify benefits, but these are implied in the magnitude of activities taken in the presence of TCs.)

Academics often qualify their evaluation of EPIs with a vague "subject to minimal transaction costs," but these qualifications are insufficient when discussing the policy potential of EPIs. It's one thing to posit the existence of a market for bicycles, and another thing to explain how well that market operates (if at all) under the influence of search, negotiation and delivery costs that may be even larger than the "price" of a bicycle.

Uncertainty

Imperfect knowledge of real or potential actual policy achievements obstructs assessment of ex-post EPIs as well as the baseline counterfactuals essential to understanding their relative impact. This uncertainty over outcomes influences policy discourses and choices.

Uncertainty assessment illuminates "confidence" in an EPI's environmental, economic and social impacts. Environmental and economic outcomes are generally assessed using direct measurements from large samples or best practices of inference. There are few cases of low confidence in data quality. Social impact indicators, in contrast, are often based on data of limited quality or educated guesses.

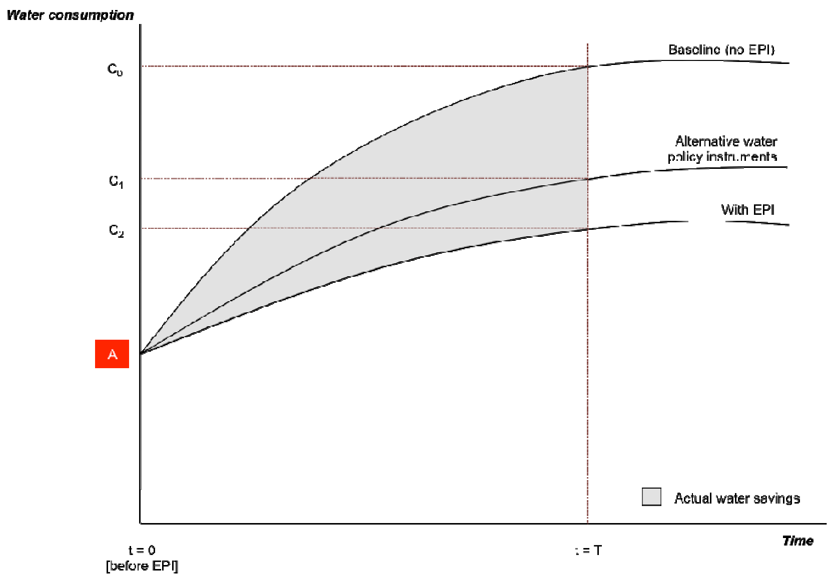
The pedigree analysis based on van der Sluijs et al (2005) was suitable for evaluating and displaying information and the processes of producing knowledge.

Criteria interactions

It is difficult to use an AF that simultaneously asks authors to consider an EPI one criterion at a time and then asks the authors to weight and aggregate these criteria into an overall assessment of EPI performance, especially when the borders among the criteria (e.g., economic costs and transaction costs) may seem arbitrary. It's even harder to reflect on the relative importance of criteria when their relative weights may change with the case study and the observer. Our case study descriptions go some way towards addressing each of these problems, exploring EPI performance over a number of pages instead of creating a single, numeric "outcome," but such a nuanced approach requires unusual attentiveness from readers, something that is hard to find among policy-makers who are often pressed for time and the need to give stakeholders fast and definitive decisions.

1.3 Assessment against what baseline counterfactual?

After the challenge of evaluating and weighting seven criteria comes the greater challenge of assessing EPI performance against a baseline or counterfactual case without the EPI. Figure X shows three trajectories over time. The highest line shows how baseline water consumption would rise without the EPI, starting at time t=0 and passing through time t=T, where the evaluation is conducted. The evaluation requires that we can measure the impact with an alternative instrument as well as the impact of the EPIs implementation. Given the typical lack of information on baseline and alternative instrument performance (ex-post case studies had data on EPI impact because the EPI was actually implemented), getting these counterfactual data requires a combination of luck, foresight and imagination.



Source · IMDEA Water Foundation

In 20 of 28 case studies for which we have authors' self-evaluated judgement, they were able to establish a counterfactual baseline of "what would have happened without the EPI." These baselines were mostly based on imagination, i.e., extrapolation of the pre-EPI trend or evaluation against theoretical alternative (the case with 13 of 20 case studies with a baseline); seven of 20 studies had baselines that were based on comparison groups, improved data, etc.

This less-than-hoped-for outcome is normal in policy evaluation (as opposed to testing a falsifiable hypothesis in a scientific lab), since it's very difficult to separate real people in the real world into two groups that are identical except for the existence or absence of the EPI. The ex-ante assessment process means that we had to take the data we could get.

1.4 Applying these lessons to WP4

In WP4, we can try to collect more data on criteria of interest. We may even be able to conduct a quasi-random field trial similar to the common practice in development economics. In a typical trial, for example, two sets of reasonably similar villages are monitored for outcomes of interest (e.g., malaria transmission), the treatment set of villages subject to an EPI (mosquito nets given away), and the control set left to chart their own paths (mosquito nets for sale, or not). Such a comparison makes it much easier to measure impacts and make recommendations to policy makers.

PART III – The Assessment Framework

2. Structure of the framework

2.1 Introduction

The Assessment Framework (AF) consists of:

- A unified conceptual scheme of the ex-post and ex-ante assessments of Economic Policy Instruments (EPIs) described under WP3 and WP4 case studies (task 2.8 in the DoW);
- Indicators appropriate to specific EPIs (tasks 2.1– 2.7);
- A toolbox of guidance documents and/or protocols that deliver uniform assessment of WP3/WP4 case studies (task 2.9).

The AF collects assessment criteria, assumptions and choices. Outcome-oriented criteria describe EPI performance, costs and induced effects. Contextual criteria describe conditions influencing EPI outcomes. Assumptions are necessary to connect policy outputs to outcomes; separate and quantify the impact of the EPI on empirical outputs/outcomes that are affected by other factors; forecast future outputs/outcomes; and estimate what baseline path would have occurred in a counterfactual scenario without the EPI (see Figure A-1). Choices include additional parameters applied during the assessment exercise such as the discount rate.

Indicators are qualitative or quantitative, direct or indirect (proxy) values of outcome-oriented and contextual criteria. Indicators can be specified as exact values, ranges (due to inexact measurement of impacts); or qualitative indicators. Indicators can also reflect temporal and spatial elements, to control for EPIs that have different effects over time or create spill over to adjacent communities. A groundwater extraction fee, for example, may reduce groundwater extraction during a wet period but be too low to matter in a dry period. In the same sense, the fee may affect an adjacent jurisdiction outside the fee's implementation area.

Policies target objectives with EPIs that will deliver outcomes. Outcomes that are difficult to measure are often approximated by intermediate proxy outputs (see Table A-1). An EPI that aims for an outcome of reduced residential water consumption (demand) may result in outputs such as higher sales of water-efficient appliances. Outputs are easier to trace, but they may be imperfect proxies for outcomes. A value of subsidies provided for water-efficient appliance, for example, does not provide a good estimate of total water savings if we are missing data on how households use those appliances.

The toolbox describes methods, models and other tools that can be used to evaluate criteria via indicators. A guidance document clarifies which tools are best for assessing an EPI, given information constraints and the expertise of the assessor.

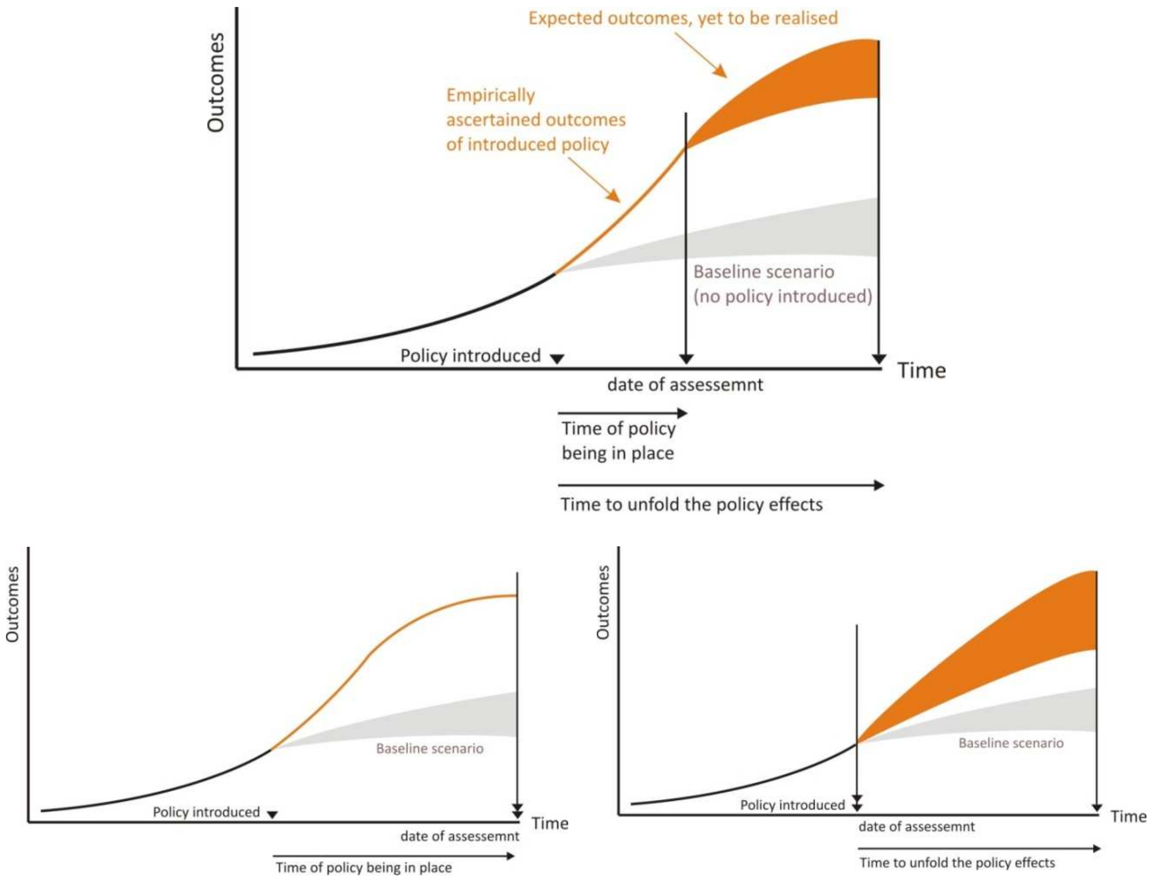


Figure A-1. Ex-post assessment compares outcomes after implementation of the EPI to a counterfactual baseline (bottom left). Ex-ante assessment compares the baseline future to the EPI-modified future (bottom right). Ex-post assessment may also compare future trajectories (top).

Table A-1. Examples of policy outputs and outcomes

Policy domain	Objectives	Outcomes	Outputs
Drought and water scarcity	Reduce disaster risk/Ensure water security/Improve preparedness/Increase community resilience	Population affected by mandatory water restriction/rationing	Per-capita water consumption/Count of water–saving appliances
Flood risk		Ratio of insured to uninsured flood losses	Insurance market penetration
Water quality	Achieve GES (Good Environmental Status)	Concentration of priority substances in water bodies	Population connected to tertiary sewage system

2.2 Economic policy instruments (EPIs)

The EPI-WATER project analyses EPIs that use different means to reach objectives. EPIs can spur behavioural change through incentives or disincentives; change conditions to enable economic transactions, or reduce risk. The variety of EPIs means that the AF needs to be flexible enough to accommodate particular EPIs but specific enough to allow side-by-side comparisons of these EPIs.

Policies and objectives: A policy is assessed against the objectives for which it is designed. An insurance policy, for instance, targets resilience as an objective (hedging against low probability, high impact events such as floods, for example). This EPI would be assessed according to the extent to which it achieves the objective and its relative performance against other policies (e.g. state compensation/relief scheme) or measures (e.g. structural defence) targeting the same objective. Thus we can see that EPIs will be assessed against their objectives as well as compared to other policies. Assessments will go beyond direct effects, to include side effects (positive and negative) that were not considered when policies and objectives were designed or implemented.[1]

Objectives may be quantified (e.g. halve household water consumption) or generic (reduce water stress). They may be single or multiple, implicit or explicit. We assume that policy objectives for WP3 EPIs are either explicitly specified at the time of implementation or implicitly revealed by the choice of policy. We compared EPIs with similar objectives and made adjustments for EPIs that target multiple objectives.

Clearly, EPIs have received widespread attention over the last three decades, and have increasingly been implemented to help achieve environmental policy objectives, often due to their (allegedly) superior efficiency compared to classical "command-and-control"-type regulation. (Grimble 1999; Pearce & Howarth 2000; REC 2001; Kraemer *et al.* 2003; Merrett 2004; Cantin *et al.* 2005; Da Motta *et al.* 2005; Sawyer *et al.* 2005; EC 2007; Pablo *et al.* 2007; Al-Marshudi 2008; Editorial 2008; Russell *et al.* 2009). Rather than specifying a particular type of behaviour that the regulatee has to comply with, economic instruments create the economic incentives (e.g. price signals) to encourage or discourage certain behaviour, but leave it to the regulatee to devise his / her own way of dealing with this incentive. Table 2-A describes the most common EPIs, their functions and purposes.

Notwithstanding well-established theoretical foundation, actual use of EPIs is relatively recent and implementation differs among countries and applications (groundwater quantity versus surface water quantity, for example) (PRI 2004; Cantin et al. 2005).

[1] Side effects are also called ancillary effects, externalities, or spill-overs.

Table 2A: Categories of EPIs

Type of instrument		Function / main purpose
Pricing	*Water tariff*	Price to be paid for a given quantity of water (or sanitation service), either by households, irrigators, retailers, industries, or other end users. Although prices obviously contribute to collect financial resources for the operation of a given water service (that is, they are also a financial instrument), in strict sense they can only be said to be economic instruments should they create incentives to promote water use efficiency, via deliberate changes in consumer behaviour.
	Environmental tax	Compulsory payment to the fiscal authority (whichever it is), where the benefits provided to the taxpayer are not directly linked to the payment (that is, when there is no immediate real consideration). Thus, it is an unrequited payment (i.e. there is no link between the payment and the water service rendered). They are levied on the measured or estimated effluents of noxious or other harmful substances to water bodies, the effluent collection and treatment, water abstraction, etc. They are considered economic instruments (besides their revenue-raising financial function), as long as they intend to modify behaviour.
	Environmental charge (or fee)	Compulsory payment for a service to the competent body. As opposed to taxes, charges or fees are requited payments; their function, though, as economic instruments, is alike.
	Subsidies on products	Unrequited payments from government bodies to producers, with the objective of influencing their levels of production, their prices or the remuneration of inputs. They can also be paid to houselholds to subsidy consumption. They are said to be environmental subsidies (and therefore EPIs for water management), if reducing the use of some proven, specific negative impact on the water environment.
	Subsidies on practices	Unrequited payments from government bodies to producers to increase the attractiveness of more sustainable production processes that limit negative impacts on water sources or produce positive environmental externalities.
Trading	*Tradable permit for abstraction*	Right or entitlement of an individual (either natural or legal person) to use water from a given source (i.e. river, pond, stream, aquifer, etc.), under the conditions and with the attributions resulting from law. "Water use" must indeed be read in a broad sense: consumption, abstraction, discharge, etc. Water rights, within trading systems, can be exchanged thus creating incentives to improve allocation (efficiency) of water quantity amongst different sectors (including the natural environment).
	Tradable permit for pollution	Right or entitlement of an individual (either natural or legal person) to pollute the water environment under certain limitations and conditions, through the discharge of a toxic substance or wastewater effluent. Tradable pollution permits, once exchanged on a voluntary basis, may create incentives to abate pollution at an aggregate level.

Table 2A: Categories of EPIs (Continued)

Type of instrument		Function / main purpose
Cooperation[2]		Negotiated arrangement between parties to promote good practices for the reduction of pressures on water resources often linked to subsidies or compensation schemes. Settlements to preserve water resources and to share benefits thus obtained (i.e. voluntary agreements, inlcuding PES schemes).
Risk schemes	*Insurance*	Insurance (risk management instrument primarily used to hedge against the risk of a contingent, uncertain loss, for example in the event of flood or drought)
	Compensation mechanisms	Offsetting schemes where liability for environmental degradation leads to financial payment that is allocated to compensation for environmental damage.

2.3. Assessment criteria

The criteria for assessing EPIs describe outcomes and contexts. Outcome-oriented criteria describe how EPIs perform. They include intended and unintended outcomes; transaction costs from negotiating and enforcing policies; and the distribution of benefits and costs among the affected parties. Context criteria describe the institutional conditions (legislative, political, cultural, etc.) affecting the formation and operation of EPIs, the robustness of the EPI with respect to uncertain conditions, and process of implementing the EPI.

The EPI-WATER Description of Work lists criteria as Tasks 2.1 to 2.7 under Work Package 2. For the purposes of this document (and future discussions), we have reorganized these tasks to improve the evaluation flow and to emphasize links between the different criteria (see Figure A-2). Outcome-oriented criteria are divided into environmental and economic outcomes and social distributional effects. The context represented by coupled human and natural systems (aquatic ecosystems and water uses that are connected through man-made infrastructure positioned within the global institutions and economy) is integrated into the assessment through the

[2] For the purposes of this project and because of its current relevance as an instrument for water policy in Europe, Voluntary Agreements (VA) have been included (under cooperation) as an *ad-hoc* item in the broad categories of EPIs. It is worth noting, though, that there is an on-going debate in the literature about whether voluntary agreements (VA) can be regarded as a "pure" economic policy instrument or not. Environmental VAs are commonly defined "as an agreement between a government authority and one or more private parties with the aim of achieving environmental objectives or improving environmental performance beyond compliance to regulated obligations. Not all VAs are truly voluntary; some include rewards and/or penalties associated with participating in the agreement or achieving the commitments" (Gupta et al., 2007). Some economists interpret the "Voluntary" nature of the agreements as a version of regulation and therefore, argue that they do not belong to the economic policy instruments category.

analysis of institutions, policy implementation and transaction costs. These dimensions are described briefly below; Part II contains extended descriptions.

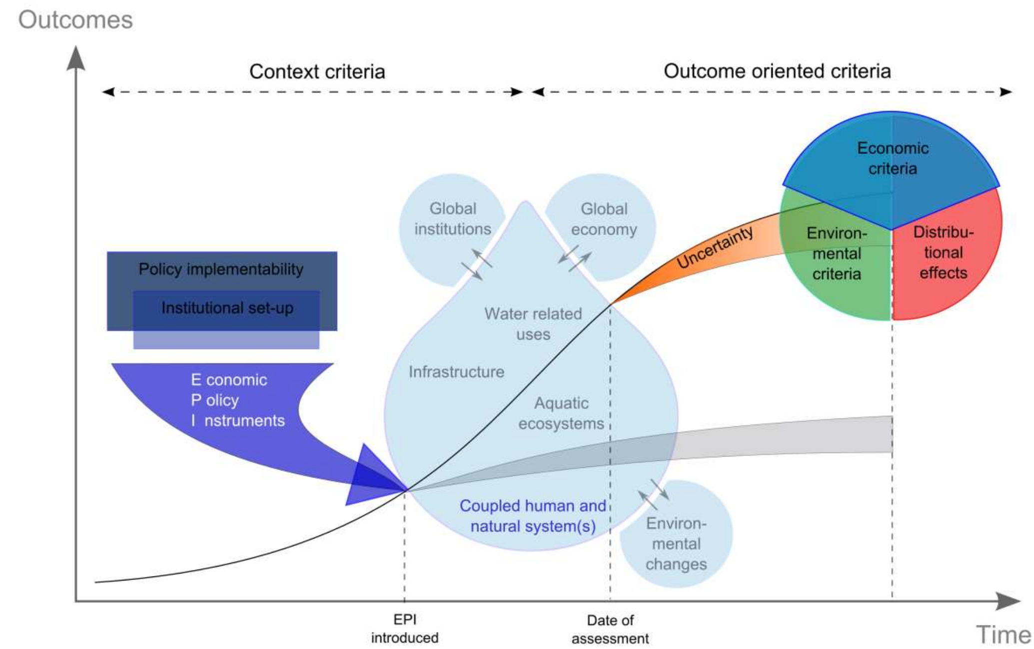


Figure A-2. Conceptual schematic diagram of the EPI assessment framework

Tasks and criteria relate in the following way: EPIs target objectives by producing outcomes on environmental (1.3.1) and economic (1.3.2) dimensions. These outcomes are associated with distribution patterns (1.3.3) that affect the social impact of an EPI. Impacts for all three of these criteria are subject to the influence of institutions (1.3.4), which affect the process of implementing the EPI (1.3.5) and the transaction costs associated with design, implementation and operation (3.1.6). Observed outcomes reflect one realized set of potential outcomes. Future circumstances may not produce the same outcomes (for good or ill), so it's necessary to understand how the range of outcomes may vary with uncertainty (1.3.7).

2.3.1 Environmental outcomes

EPIs target water policy objectives (e.g., reduce water demand or maintain WFD quality standards) or increase the social value of water by changing incentives to direct behaviour towards collective goals. EPIs that target environmental outcomes will be assessed by comparing actual outcomes with alternatives (no action or regulation, for example) and evaluating positive and negative side effects. This criterion will consider the response of economic agents to EPIs in terms of changes in demand for water services; the impact of these changes on the ecological status of water-related ecosystems, and the value of the environmental goods and services from these ecosystems to humans.

2.3.2 Economic outcomes

This task provides an economic synthesis of the contents of criteria 2.3.1, 2.3.3 and 2.3.6 to facilitate evaluation of the outcomes. The economic assessment will evaluate the EPI based on efficiency using a cost-benefit analysis (CBA) principle that integrates consideration for incomplete and/or unreliable economic estimates. In addition, EPIs will be evaluated according to cost effectiveness, cost savings, distributional effects (1.3.3 examines the equity and ethical considerations from this distribution), risk reduction (with some evaluation deferred to 2.3.7), cost recovery, and incentive compatibility (including asymmetric information issues). Effects directly linked with environmental outcomes in 2.3.1 will be used as an input to the analysis here.

2.3.3 Distributional effects

The distribution of goods and burdens across different groups affects social equity and acceptability of EPIs. There are many arguments made in the social justice literature as to what constitutes a 'just' distribution. In EPI-WATER we focus on social equity and take it to mean reducing the inequalities between stakeholder groups. This criterion focuses primarily on assessing the nature of the distribution, highlighting inequalities in the allocation of goods and burdens as a result of the implementation of EPI. Assessment will consider both proxy indicators based on quantitative data and quantitative subjective measures of well-being (Stiglitz Commission 2009). These results will be assessed by comparing pre- and post-EPI implementation conditions. Results based on a simple +/=/- metric will highlight existing inequalities and changes due to the introduction of the EPI across various groups.

2.3.4 Institutional background

Institutions are the formal rules and informal norms that define choices by affecting the cost of exchange (transaction costs) and production (transformation costs) (North 1990). Most institutions are difficult to describe, highly adapted to local conditions, and effective in balancing many competing interests. Institutional constraints vary in strength, depending on their level; see Figure 4-A. We will separate institutions and transaction costs (TCs, in 2.3.6) in our analysis by associating institutions with exogenous impacts on EPIs and TCs with the fixed costs of implementing an EPI and variable costs of using it. A water market, for example, is established with fixed TCs and operated with variable TCs, but both are affected (positively and negatively) by institutions. These effects should be kept distinct from the impacts of EPIs that create/modify institutions (e.g., new markets or tax adjustments, respectively) or influence the institutions of existing markets and bureaucracies, choices and behaviour (e.g., water law, policy or administration).

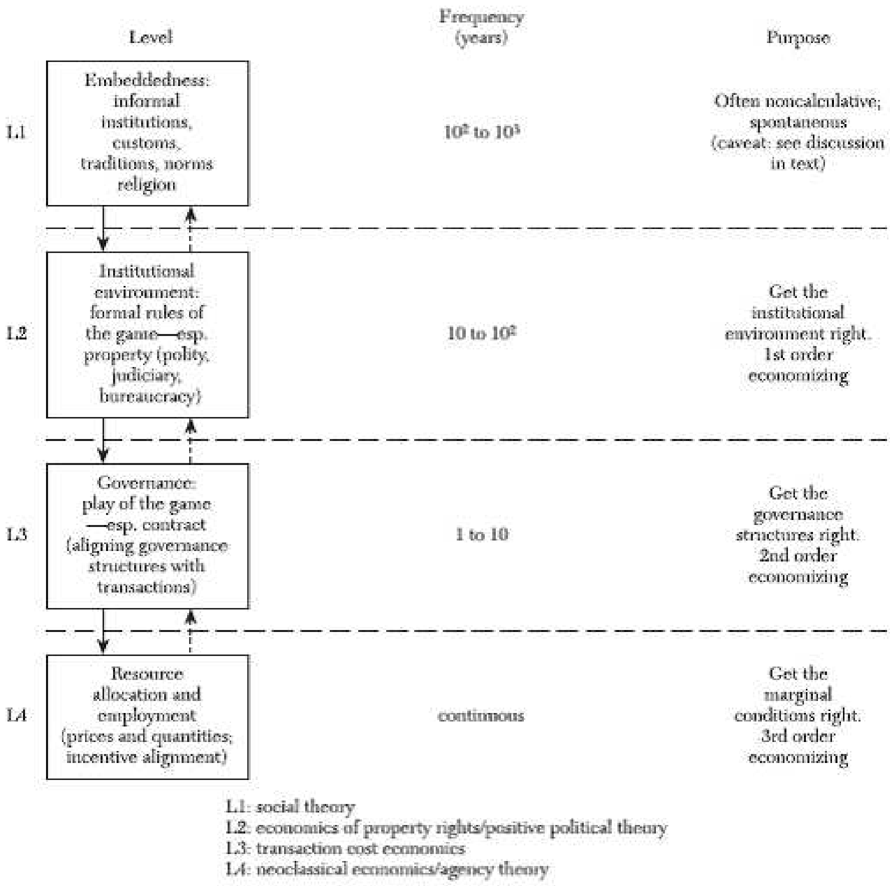


Figure A-4. Institutional levels from Williamson (2000)

2.3.5 Policy implementability

As part of the policy cycle, the *policy implementation phase* is critical as the theoretical ideas of the policy (instrument) need to be adapted to match practical realities. It is not a clear-cut and automatic process which occurs following the adoption of the precedent legislation but may be limited by a number of factors which affect the ability of the political system to put policies into effect to achieve the desired outcomes.

The task identifies and defines key factors that are important for implementation of EPIs and recommends methods for their measurement and elicitation for their evaluation. The assessment draws upon the analysis of four main themes, namely the adaptability of the EPI, public involvement, institutional factors as well as the influence of external factors, such as EU sectorial policies on the EPI implementation.

2.3.6 Transaction costs

Transaction costs (TCs) from implementing or using EPIs are different from typical direct costs. Krutilla and Krause (2010) examine "TCs related to the creation, implementation and operation of environmental policies." Their analysis refers to ex-ante TCs (e.g., negotiating new property rights) and ex-post TCs (e.g., monitoring costs). They also refer to "factors affecting the magnitude of TCs" such as cultural norms, the state of technology, etc. These exogenous factors affecting EPIs are examined under section 2.3.4. We use Krutilla and Krause's classification of TCs - noting that ex-ante TCs are equivalent to fixed costs and ex-post TCs are equivalent to variable costs associated with the EPI. We identify TCs by examining the flow from design and implementation (ex-ante) to monitoring and enforcement (ex-post). Asymmetric information falls under TCs in two ways. Ex-ante and ex-post TCs can change the information environment (e.g., establishing and running a monitoring program). Asymmetric information can impose visible and invisible TCs, e.g., the costly change in behaviour in response to incomplete information.

2.3.7 Uncertainty

An EPI's impact on any criterion is subject to uncertainty from imprecision (missing knowledge, estimation, inaccuracy or ambiguity), complicated interactions among policies, and/or future costs/benefits. For EPI-WATER, we propose to use the pedigree analysis inspired by van der Sluijs et al (2005). The pedigree represents an explicit account of the quality of information and the processes underlying the knowledge production process. The pedigree criteria are assessed through expert judgement, using qualitative statements.

2.4.Terminology

Assessment. The assessment is a systematic and methodological analysis of an intervention or situation, aiming at informing decision-making.

Cost. Costs usually comprise efforts, material, resources and time consumed, risks incurred, and opportunities forgone in order to reach a policy goal.

Cost-effectiveness. Cost-effectiveness has been labelled the "relaxed approach to the measurement of efficiency". It is the measure of the relationship between (money measured) inputs and the desired outcome, such as for example between the expenditure on the creation of water markets and the reduction of pressures on water-related ecosystems.

Criteria. Criteria are rules used for judgement, in this case of policy instruments. The definition of criteria and of the respective indicators is part of the assessment design defined, in the case of the EPI-WATER project, in the overall assessment framework.

Effectiveness. Effectiveness is the degree to which policy goals are achieved by implementing the policy instrument considered. In contrast to efficiency, effectiveness is not determined with reference to costs and compares the outcome achieved by the use of a policy tool with the policy goal.

Efficiency. Efficiency relates to the achievement of maximum social welfare. More (or less) efficient policy instruments can be identified using a social welfare indicator for a comparison with a benchmark.

Impact. Impacts are the effects of a policy intervention on environment and society. Impacts can be either positive or negative, foreseen or unforeseen. Immediate impacts are called results, whilst longer-term impacts are called outcomes. Because of the more generic character of the term "impact", it is proposed to use the terms: outcome (long term impacts), side effect (unforeseen impacts) or output (amount of goods and services produced).

Indicators. Indicators are qualitative or quantitative parameters which represent the information needed for measuring change, in this case provoked by policy interventions (EPIs) on criteria. In order to be useful, indicators need to be able to represent trends which are significant for the policy or measure under exam. They measure key issues in relation to a criterion for decision making, often by representing larger realities in a single and comprehensive measure, as for instance CO2 emissions are used as an indicator for the whole array of climate relevant emissions.

Outcomes. The outcomes comprise all long-term consequences which can be attributed to the policy implementation, comprising both intended and unintended (targeted and not targeted) side effects or impacts, for instance in terms of pollution levels or international competitiveness of a domestic industry.

Output. Measurable direct effect of a policy, e.g. an amount of certain goods or services directly produced attributed to the implementation of a policy.

Policy. A policy is a set of principles and terms guiding the governance of particular social, economic or environmental issues, implying the use of procedures or instruments for reaching some given objectives, goals or targets.

Policy goal. Objective to be achieved by implementing a policy and the respective instruments. Environmental policy objectives can be defined either in relation to the state of ("Good Environmental Status", GES), or the pressures on ecosystems (generally aiming at their reduction). Policy goals can be subject to discrepancies between stated and (frequently hidden) real policy goals.

Policy Instruments. Mechanisms designed by policy makers to direct outcomes towards a targeted objective

Policy targets. Rather than generic objectives, policy targets are policy goals which have been defined in quantitative terms.

Risk. The combination of the probability of an event and its negative consequences (UNISDR 2009).

Side effect. Side effects are policy outcomes that are not explicitly connected with the policy goal, comprising (positive or negative) impacts on ecosystems, economic and social structures.

Uncertainty. Uncertainty exists when details of situations are ambiguous, complex, unpredictable or probabilistic; when information is unavailable or inconsistent; and when people feel insecure in their own state of knowledge or the state of knowledge in general (Brashers 2001).

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PART IV – Background Annex

3. Environmental Outcomes

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3.1 Introduction

Water policy is about making economic development and social welfare enhancement compatible with the improvement and protection of water resources (see Figure B-1). Water and water-related ecosystems provide the economy with flows of water services or primary materials for the production of many valuable goods and services such as drinking water, food, electricity, manufactures, tourism services, etc. The quantity and quality of all these water services as well as its stable provision depend on the state of conservation of all those ecosystems.

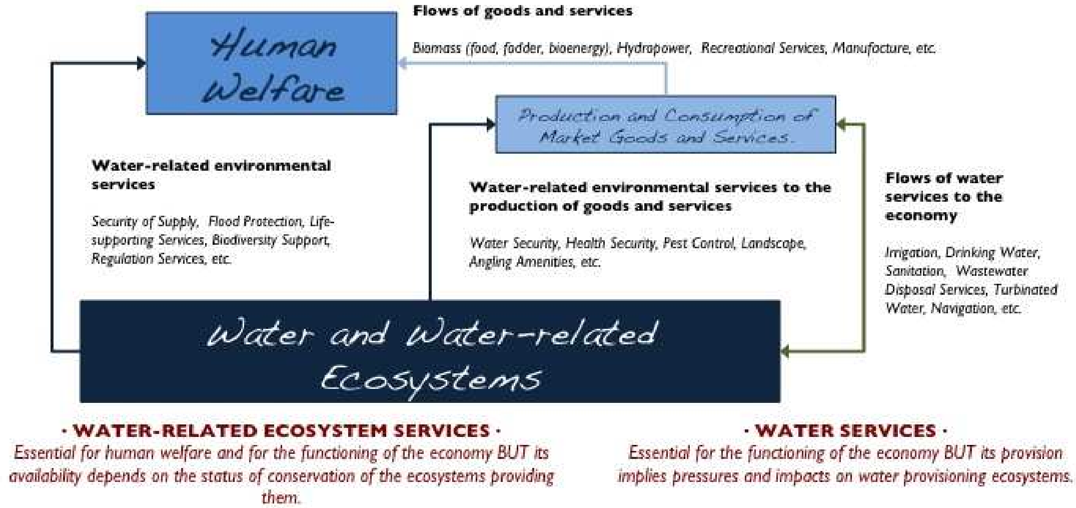

Figure B-1. Water Services, Ecosystem Services and Welfare (Source · Own elaboration)

None of these water services can actually be provided without a detrimental effect on these ecosystems (that is to say without water abstractions, impoundments, diversions, and so forth). Hence, assessing the environmental outcomes of water policy instruments requires a clear understanding of the supply and demand of these water services and, particularly, a notion on how these services are provided to the economy (with more or less impact on water ecosystems) and on how much welfare

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the economy is able to produce (by allocating and using them with more or less efficiency and fairness).

Besides providing water services to the current production of goods and services for the economy, water-related ecosystems provide a number of important environmental services, which are essential for human welfare and for the ceaseless functioning of the economy. These services include, for example, water and health security, flood control, biodiversity support and all the water regulation services, essential to preserve both water and ecosystem services.

As above, the availability of all these environmental services depends on the status of conservation of the ecosystems providing them. Modern water policy objectives are therefore defined in terms of a desired status of conservation of these water-related ecosystems. The choice of the appropriate policy instruments is thus based upon their ability to adapt the performance of the economy to these goals.

Economic instruments are just but a kind of the different alternative means available to the ends of water policy. The essential characteristic of an EPI is that it is an incentive deliberately designed and implemented in order to make individual economic decisions compatible with some policy goal. Economic instruments for sustainable water management, as considered in EPI-WATER, are consequently designed and implemented both to induce some desired changes in the behaviour of all water users in the economy (individuals, firms or collective stakeholders) and to make a real contribution to collectively agreed water policy objectives (NCEE, 2001; Stavins, 2001; Kraemer et al., 2003; UNEP, 2004; PRI, 2005; ONEMA, 2009; OECD, 2011).[3]

Yet, behavioural changes, which are the direct purpose of EPIs, are indeed just transitional objectives to meet the true aims of water policy: the collectively agreed status of water bodies. The latter generally consist of achieving,[4] maintaining and protecting a given ecological status of water bodies (Riegels et al., 2010).

Whatever assessment of the effectiveness of any policy instrument (in particular when they entail setting the incentives behind actual human behaviour), does not only require an analysis of the impact on the environment of intended changes in the economy, but also a consideration that “closes the circle,” namely to show how environmental changes would in turn impact on the economy and social welfare (see Figure B-1).

[3] Within the scope of EPI-Water and the assessment of environmental outcomes, the effects of water policy on other sectors will also be assessed (it is of paramount importance to do that as part of the assessment of instruments). On the contrary, the effects of other policies on water will not be analysed since this is part of the analysis of scenarios in which EPIs are to be assessed.

[4] The achievement of an ecological status, as in the WFD, means, by definition, an improvement.

Summing up, we can conclude that assessing the environmental outcomes of EPI implementation implies searching for an answer to the following relevant questions (see Figure B-2):

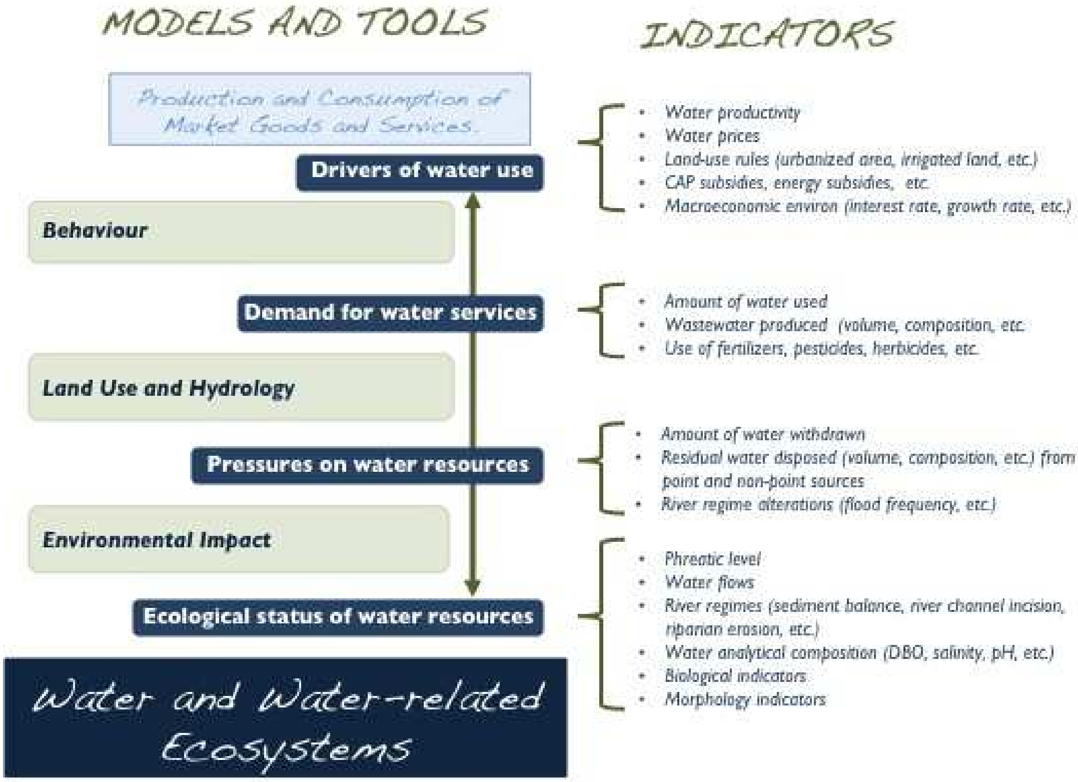

Figure B-2. Steps to Assess Environmental Outcomes Roadmap: Models, Tools and Indicators (Source · Own elaboration)

What are the economic agents' intended or effective responses to EPIs in terms of a variation in the quantity and quality of those water services demanded or supplied?

- Answering this question requires an understanding on how decisions on water services use depend on the different economic, political, and institutional factors that explain how water is used in the economy (see section 0). All these drivers of water use as well as of the demand for water services in each relevant economic activity, can actually be described by a set of indicators (as shown in Figure B-2), and the connection between the drivers and the demand for water services is explained by behavioural models and analytical tools. Indicators are useful to describe the baseline and the intended and realized outcome of an EPI, in the same way that models and tools are essential to design and assess EPI effectiveness.

How do these changes in individual behaviour translate into lower (or increased) pressures on water providing ecosystems? (See section 0)

- This question requires comprehension on how efficient the production of water services in the economy is, in the sense that satisfying a certain demand of water services (for example of water for irrigation) requires more or less pressures on the water environment (depending on the technical efficiency of abstraction devices, transport, delivery and application system in place). It also implies to understand how the concerned economic activities affect the water environment (for example by affecting runoff, erosion rates or by diffuse disposal of pollution loads)

What are the likely or observed impacts of changes in pressures on the ecological status of concerned water-related ecosystems?5 (See section 0)

- To answer this question it is critical to realize how pressures directly and indirectly affect water bodies. As in the previous question, some available indicators can describe pressures and the ecological status of water bodies but linking one to the other will require appropriate models and tools (Figure B-2).

How changes in the status of water providing ecosystems would affect their potential to provide society with increased (or decreased) flows of environmental goods and services (or benefits)? (See section 0 and Figure B-2).

How valuable are these benefits? (See section 0)

All the discussion about the convenience of implementing innovative EPIs or about the failure or success of previous experiences is based upon the expected or actual answers to the above-mentioned questions. Moreover, an overall assessment of the effectiveness and the economic benefits of EPIs for water management is rarely found in the literature, maybe with the exception of models combining hydrological and economic analyses. Most of the available information on the effectiveness of EPIs does refer to *ex-ante* evaluations, often based upon optimistic design (when not simplistic) assumptions, that is to say not necessarily confronted with realized outcomes. As shown below, in the different examples used to explain the steps of the assessment approach, rather than offering a comprehensive response, most relevant publications on the subject seem to have focused on solving one of the above-mentioned questions. This implicitly suggests the remaining answers will go in the same direction.

3.2 Typology of EPIs according to their intended primary environmental outcomes

The scope for the assessment of environmental outcomes depends on the intended environmental outcome of the concerned EPI. This may be:

1. The improvement of the status of water bodies.

   a. To increase water availability (abstraction and use, charges, etc.)

[5] One may argue that there are no water-related ecosystems as a separate class since all ecosystems have a water component. Yet, reconciling the use of terms such as water bodies, river basins, and ecosystems is not straightforward and is a non-solved problem in the literature (Kohli et al, 2010; Moller, 2009).

- EPIs addressed to obtain quantifiable reductions of water services demanded by a defined set of users in some economic activities and at some given places. This is, for example, the case of incentives to reduce water demand for irrigation (Turner et al., 2004; Bartolini et al., 2007; Rosegrant et al; 2009; Pinheiro and Saraiva, 2009; Olmstead, 2010), household consumption (Millock and Nauges, 2010; Nataraj and Hanemann, 2011) or manufacturing (Worthington, 2010).
- EPIs to increase the efficiency with which these water services are provided. This is the case of EPIs designed to abate pressures on water bodies stemmed from the need to satisfy a given demand of water service provision. These tend to include incentives to promote more effective irrigation systems (Perry et al., 2009), investment on improving water distribution networks or replacing assets (Tang et al., 2007), better water transport systems (Howitt et al., 2010), use of recycled water in manufacturing processes (Chen and Wang, 2009), etc.
- EPIs to promote substitutions of water supply sources in order to reduce pressures on water bodies associated with the provision of a given set of water services, both for production and consumption activities. This is, for example, the case of incentives performed to promote the substitution of alternative resources (such as regenerated or desalinated water) for freshwater (Gleick, 2000; Zhou, 2005; Riegels et al., 2010) or to shift water supply from some traditional sources to others with lower negative impacts, etc. (Farreny et al., 2011; Mitchell et al., 2005).
- EPIs to reduce risk exposure to extreme events such as droughts and floods as in the case of incentives to deter land settlements in hazard zones or to promote water stress-resistant crops in drought-prone areas (Mendelsohn and Saher, 2011) or resilience and resistance measures for floods.

b. To improve water quality (i.e. on the basis of physic-chemical attributes): water pollution charges, effluent fees, payment for environmental services, etc.

- EPIs with the potential to reduce the negative impact of providing the economy with waste disposal and treatment services. They include, for example, incentives for investing in more efficient effluent treatment plants, reducing point and diffuse pollution loads, etc.

c. To improve hydromorphology (labelling, voluntary agreements for hydropower, etc.).

- EPIs to reduce impacts of specific economic activities on the structure and functional activity of water (providing) ecosystems. This may be the case of incentives to reduce hydropower impact on river ecosystems (Batalla and Vericat, 2009), to promote agricultural practices that increase soil conservation (Prager et al., 2011), reduce deforestation (Ring et al., 2010), minimize floodplain occupation (Mori, 2010), etc.

2. To allow production or employment improvements within the range of existing water pressures (i.e. water reallocation amongst use: no impact pathway analysis is required in this case except for showing that water pressures have not changed, no third parties are damaged, etc.).

It should be clear that should there be no change in behaviour, then one might expect no environmental outcome. EPIs are incentives; therefore a necessary condition for them to deliver any environmental outcome is to change the demand for water somehow (reducing water use or wastewater loads, installing more effective water use devices, improving water use practices, engaging in water restoration measures, etc.).

There are two main reasons why no environmental outcome might be captured through the use of this methodological approach: either the outcome was not intended (i.e. the environment is a good alibi to make taxes acceptable and even for rent seeking and regulatory capture) or the outcome was actually intended but the EPI failed because of wrong design of its delivery mechanism (a flat rate instead of a marginal price, too much moral hazard, no monitoring and enforcement in place, too low prices and too inelastic demand, the one who pays is not the one who cares for pollution or for water use…). This would be the case of a wrong (ill-defined) EPI, but an EPI after all.

3.3 Assessment methods and techniques

This section presents the analytical methods available for the assessment of the environmental outcomes according to the road map presented above.

3.1.1 Modelling behaviour[6]

The analysis of intended and observed changes in individual decisions and of incentives required to attain a given outcome (such as a reduction in water demand), requires a proper understanding of the drivers of water use decisions. At an individual or activity scale this analysis can be based on existing or *ad hoc* water demand functions, able to inform on how water demand responds to, for example,

[6] There are clear links between this issue and other WP2 tasks. After all, EPIs are incentives to induce behaviour changes and this links to labour demand (employment), income effects (distribution), bargaining (institutions, competition, market power), opportunity cost (cost-benefit analysis), etc.

changes in prices and income. This can be the case of the dynamic modelling of water demand and adaptation strategies to climate change in power stations (Koch and Vögele, 2009), estimations of residential water demand (Schleich and Hillernbrand, 2009), etc.

Farmers' decisions, for instance, depend on a number of technical, economic, policy and environmental constraints. Additionally, in the case of water demand these constraints vary with space, according to land vocation, access to water use rights, water tariffs and availability of irrigation infrastructure, in such a way that a large scale or aggregated model might be vague about the driving forces behind water demand. Nevertheless local and low scale models require detailed information and their results might not be easy to generalize or aggregate.

So far, the construction of water demand simulation models is confronted with a trade-off between the model's capability to provide numerical results for policy evaluation and the coherence with basic economic principles. The need to represent complex decision problems with limited information has fostered the use of Positive Mathematical Programming (PMP) to simulate farmers' behaviour and to obtain water demands of which many are reported, for example, in Henry de Frahan et al. (2007), Berger et al. (2007) and Heckelei and Britz (2005). Apart from PMP, most of the existing simulation models that have been successfully used as tools for policy evaluation in many advanced countries are based on multi-criteria decision methods (MCDM) (Sumpsi et al., 1996; Bazzani, 2005; Bazzani et al., 2005; Feás and Rosato, 2006; Latinopoulos, 2009; Bartolini et al., 2010). Moreover, the assumption that farmers respond with linear preference orderings to changes in the policy, resource and economic environment and, similar to PMP, the use of a calibration mechanism effective but not rooted in explicit economic principles, are nevertheless issues prone to discussion. Models using a preference representation coherent with basic economic principles are for example found in Gutierrez and Gomez (2011). Moreover the difficulties of running proper elicitation procedures with detailed data and the programming and optimization tools available at that time made these exercises difficult to apply because of the details needed to make them useful for policy assessment and project analysis.

A useful insight of these models is the extensive demonstration on how farmers do not simply act as profit-maximizing agents and on how taking other decision attributes, such as risk aversion and avoidance of management complexities into account, provides a better explanation of current decisions.

This is also the case of partial equilibrium models showing the residual benefit that farmers derive from having access to a reliable water source at the farm, the municipality or the irrigation district (Lavee, 2010). These models may provide the basic information about the surplus that may be derived through reallocating water, as well as information on the maximum willingness to pay for having access to more water (demand) and the minimum required compensation to voluntarily accept the transfer of prevailing water use rights (supply).

An important concern when determining the environmental outcome of EPIs refers to the scope of the analysis. Results can differ and be closer to the real outcome when moving from a project, static, partial equilibrium scale to a regional, dynamic, general equilibrium analysis. In the former, for example, it is assumed that nothing changes, apart from an increase in the efficiency of the irrigation system (farmers will need less water than they used to; a subsequently lower amount of water will need to be withdrawn, transported and delivered).

Rather, in a dynamic model, farmers are able to modify crop decisions (including the surface of cultivated land) in order to adapt to the new situation. Specifically, this will be done to take advantage of the increased per-drop yield and to use the water apparently "saved" thanks to a more effective irrigation device. Within a general equilibrium framework other economic sectors can use the water redundant and this water will be sold at a lower price by the firm, which in a new scenario (i.e. after some water has actually been saved), have an excess production capacity. This is why, through ignoring how individuals and markets adapt to any institutional change, partial analysis tends to overestimate the reductions in water use (Tirado et al., 2006; Palatnik and Roson, 2009; Calzadilla et al., 2010).[7]

For a number of reasons EPIs may fail to provide the positive effects expected when they were initially designed and implemented. In water scarce areas, subsidies to foster the adoption of more effective irrigation devices may lead to an increase in water consumption, as the per-drop productivity will be higher. In those areas, as above, water saved due to a specific efficiency measure can be used to cover the structural deficit between water demand and supply, and water consumption will in fact be higher than in a counterfactual scenario (that is, the situation previous to the technical improvement). Higher water prices will reduce water consumption but could also shift water use from legal and publicly controlled sources to uncontrolled ones (Gómez and Pérez, 2012).

To assess the potential effect of an EPI on water use, the analyst must be able to isolate this effect from other alternative explanations. For example, an increase in water use, once water prices have risen, might be the result of an increase in household income, in the medium term, or rather of an exceptionally warm summer, in the shorter term. It may also be the case that the reduction in water demand in some farms after the installation of a more efficient irrigation device is the consequence of the decoupling of CAP subsidies, which made irrigated agriculture less attractive. For this reason, the best analytical tools (such as demand functions, economic and financial balances and simulation models of water users' behaviour)

[7] Several authors (Ekasingh and Lechter, 2005) have argued for more use of agent-based models or multi-system modelling as innovative approaches. As a matter of fact, agent-based models are able to deal with social and political dimensions. Agent-based modelling may both help improve the representation of the dynamics of social processes in integrated models, and also the conceptual understanding of social learning processes (Pahl-Wostl, 2002).

are those able to provide a comprehensive explanation of the various factors driving water use decisions.

3.1.2 From behaviour and water uses to environmental pressures

The connection between uses and pressures needs to be better understood in order to assess the potential of water-related EPIs not only to induce change of individual choices but, most importantly, to make a real contribution to the improvement in the ecological status of water environment. Assessing environmental outcomes of water-related EPIs thus implies a clear understanding of the links between the economy and the environment, in particular to understand how the satisfaction of water demands is connected with different pressures over water ecosystems (see OECD, 1991, for a description of the PSR framework of environmental indicators; EEA, 1995). The expertise needed to do so is available in several comprehensive hydrological, spatial and agronomic physical models.

"Saving water" is not always equivalent to "using" less water, reducing risk exposure (in terms of erosion, for instance) or improving environmental quality (including instream ecological flow). Even if water abstraction is reduced, more efficient irrigation will mean lower physical returns and the water balance will become uncertain. When water supply is not enough to balance evapotranspiration, as it happens in water scarce areas, more efficient irrigation translates into higher yields, which are related, in turn, to higher amounts of used water. All this also explains why "losses" or "savings" at the scale of an individual farm or an irrigation project are not necessarily losses in a hydrological sense.

The assessment of these effects needs a minimum understanding of rainfall and runoff patterns (hydrology) in the river basin (spatial analysis) and its use (behavioural analysis) to assess how a water policy in general and EPIs in particular would affect water pressures (abstractions and returns; pollution loads and natural assimilation capacities) not only in the project site but in the river basin as a whole. A widespread approach for measuring physical outcomes consists on using hydrological[8] characteristics as an input to holistic spatial assessment[9] through GIS

[8] Hydrological models can directly provide runoff and infiltration flows based exclusively on historical hydrological data (USACE, 2000a) or rather generate inputs to be used together with spatial data (Dalen et al., 2008, NRCS, 2004, USACE. 2000b). Among the latter group (known as Land Use and Land Use Change models, LULUC), widespread approach consists on providing curve number and minimum rainfall values as an input for further development of spatial models (NRCS, 2004).

[9] Spatial analysis models rely on hydrological and geographical data processing, mainly through Geographical Information Systems (GIS) (Pender and Faulkner, 2011). GIS models generate rainfall-runoff (and thus infiltration and erosion) data distributed along time and space. These models are mostly used for extreme events assessment, such as floods (Yusoff, 2011, Hoque, 2011).

software (Xu and Singh, 2004; McColl and Aggett, 2007; Saghafian et al., 2007). These models can be complemented with agronomic tools.[10]

In economic theory, one may also find an insightful hypothesis that explains that efficiency in water use may result in higher water productivity and, therefore, higher water demand. This is conceptualized under the proposition of the so-called Jevons' paradox or effect (Alcott, 2005; Polimeni et al, 2007; Madlener and Alcott, 2009). Contrary to common intuition, technological progress (introduction of low-pressure irrigation systems, for instance), that increases the efficiency with which water is used, tends to lead to the growth of the rate of consumption at a certain scale. Energy economists, studying consumption "rebound effects" from improved energy efficiency, have revisited this issue (Brookes, 1979; Khazzoom, 1980; Lovins. 1988; Schipper and Meyers, 1992; Howarth, 1997; Wirl, 1997; Saunders, 2000; Schipper and Grubb, 2000; Brookes, 2000; Binswanger, 2001; Sorrell et al., 2009).

Efficiency measures do actually reduce the amount of water demanded for a given use. But in addition, improved efficiency lowers the relative cost of using water, which in fact is an incentive to use more, potentially outweighing any savings from increased efficiency (Gómez, 2009; Olmstead, 2010).

Llop (2006) found out in her empirical research in Spain that, in line with this paradox, technical efficiency decreased water prices, and this raised industrial water consumption. On the other hand, the introduction of a tax on intermediate water uses led to an overall rise in prices and this significantly turned water uses down. Yet, most interestingly, the joint application of the two measures (technical efficiency, through heavily subsidized measures, plus tax on intermediate water uses), reduced water consumption, had no inflationary effects, and increased social welfare.

3.1.3 Impact assessment: from environmental pressures to the ecological status of water bodies

The likely impact of a change in water pressures on the status of affected water bodies and, in particular, on water quantity, quality, and the ecological structure and functions of the water system, also needs to be analysed. Some examples may show that the connection between pressures and the status of water bodies is not straightforward at all. For example, as water bodies are connected to each other, the water saved in a given place, for example a stream could be used to make up a deficit in other, for example the aquifer receiving the irrigation returns. To assess the effect on the different interconnected water bodies a hydrological model of the river basin is therefore required.

For example, the "non-consumed fraction" of the water used in an agricultural system inversely varies with irrigation efficiency. This irrigation returns may be partially or totally recoverable in the sense that it can be captured or re-used

[10] Agronomic models estimate physical crop production using as an input soil characteristics, meteorological variables (intensity and distribution), crop characteristics and management practices. These models are accurate but data intensive.

(through river flows, percolation to aquifers) or not at all (when water returns flow into the sea or deep non-financially feasible aquifers). The same effects can be considered when water is transferred from a water body as a result of marked transactions having negative impact in the giving basin.[11]

Furthermore, the positive effect of other interconnected water bodies will be higher should either water be saved or pollution loads controlled further upstream than, for example, near the shoreline where water savings have lower spillover effects and subsequent minor impacts.

Although the functioning of water ecosystems is still imperfectly known, assessing the potential effectiveness of water-related EPIs does require a due consideration of the potential effects of reducing water pressures both on affected and interconnected water bodies.

Since Bear and Levin (1970), Burt (1964), Booker and Young (1994), Gisser and Mercado (1972; 1973), Noel and Howitt (1982), Vaux and Howitt (1984), and Young and Bredehoeft (1972), there has been much progress in terms of hydro-economic models.

Most efforts, however, have been placed on holistic approaches, such as Cai et al. (2003), Díaz and Brown (1997), Fisher et al. (2005), or Pulido-Velázquez et al. (2006). There is some controversy in the literature, however, as to whether holistic or rather modular approaches (such as Draper et al., 2003) should be preferred. The discussion is explicit in Braat and Lierop (1987), Brouwer et al. (2007) – a holistic approach itself, and McKinney et al. (1999) – also a holistic approach. These integrated or holistic approaches are based upon the idea that an optimum can be reached both in hydrological and economic terms and, also, from an operational viewpoint, that this optimization can be performed just by introducing a parameter (shadow price, elasticity of demand, etc., provided by optimization algorithms) or, at best, a demand function (see MacKinney et al., 1999, for an insightful discussion on optimization versus simulation). Holistic models have clear advantages but, in order to solve simultaneous equations, components tend to be presented in a too simplistic way.

Although the assessment of physical impacts (either positive or negative), of EPI implementation is dealt with elsewhere in the document, it is important to emphasise on the fact that a number of initiatives has been developed regarding indicator systems. Some of them have been developed within the framework of environmental indicators (OECD, 1991; EEA, 1995); some others are more specific, such as the IMPRESS working group (WATECO, 2003b) or guidance documents produced by the governments of the UK (2004) or Ireland (2004). All these initiatives agree on the fact that data themselves might not be enough to assess impacts: a correct indicator of the expected impact must be constructed (WATECO, op. cit.).

[11] It must be stressed that since the emphasis, at this level, is to evaluate what the pressures are at the source, inputs from agronomic models, runoff models or pre-existing data on the efficiency of measures might also be relevant.

Regarding hydro-economic models, the validity of some assumptions has been questioned in recent years and the scientific community is currently aware of a number of "paradoxical outcomes" that may occur. A clear example is the so-called "efficiency paradox" can be found when analysing water saving potentials (Dworak et al., 2007), which are based on the following argument: if one is able to improve the irrigation technique, less water will be required, thus diminishing water withdrawals and water bodies will thus be in a better. But there may be a fair way to go from water saving potentials to actual ones. Besides the fact that using less water per crop does not necessarily mean using less water overall (at a farm, irrigation district or basin level), (Ward and Pulido-Velazquez, 2008 and 2008.b), likewise water losses at a farm scale are not necessarily equivalent to water losses in a hydrological sense (Perry et. al. 2009). Environmental benefits could be said to be likely outcomes rather than proven facts.

3.1.4 The status of water bodies and biophysical flows of ecosystem services

Provided EPIs succeed in changing decisions on water resources and these changes are effective in reducing pressures (thereby leading to positive impacts on affected water bodies), improved water resources will then have a higher social value and a higher potential to provide society with stronger flows of a wider array of environmental services (or benefits).[12]

Ecosystem services clearly link ecological functions and the benefits (in terms of welfare) that people obtain from ecosystems. Following the MEA's typology (MEA, 2005),[13] these include provisioning, regulating and cultural services that directly affect people, and supporting services needed to maintain the biophysical flows of the other services. Freshwater supply is an example of linkages between categories (provisioning and regulating services) (see Table B-1 in section 6.7).

Permanent water bodies inland from the coastal zone, and areas whose ecology and use are dominated by the permanent, seasonal, or intermittent occurrence of flooded conditions, provide a wide spectrum of ecosystem services. The timing and intensity of runoff, flooding, and aquifer natural recharge are strongly influenced by changes

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[12] Beyond the seminal paper by Costanza et al. (1997), and the monographic issue of Ecological Economics (vol. 25, no. 1, April 1998) around that paper, or even previous references, such as Pimentel et al. (1997), this line of research has lived halcyon days: Kreuter et al. (2001), Guo et al. (2001), Sutton and Costanza (2002), Zhao et al. (2004), Hein et al. (2005), Troy and Wilson (2006), Tong et al. (2007), Naidoo et al. (2008) or, more recently, Boyd (2010) – on ecosystem services and climate adaptation, Liu et al. (2010) or Norgaard (2010). In parallel, two initiatives led from international organizations, have contributed to gain momentum: the Millennium Ecosystem Assessment (MEA, 2003; 2005; widely discussed in Carpenter et al., 2009), called for by the United Nations Secretary-General in 2000, and the report on The Economics of Ecosystems and Biodiversity (TEEB, 2009), a programme hosted by the United Nations Environment Programme.

[13] It must be noted that Ficher et al. (2009) consider that the MEA classification is relevant to promote understanding and educate a larger public about ecosystem services, but not when the goal is economic valuation, due to aggregation and double counting.

in land cover, including alterations that alter the water storage potential of the system, such as the conversion of wetlands (Yang et al., 2008; Chen et al., 2009) or the replacement of forest areas with croplands and pastures or the urbanization of cultivated areas (Crossman et al., 2010).

The drivers of change in the provision of freshwater are mainly linked to population growth and development, water supply management patterns, land use and land cover change (Maes et al., 2009), climate change and variability, urbanization, and industrial development (MEA, 2005). These drivers, however, are linked to specific changes in water ecosystems, mainly physical changes (including drainage, clearing, and infilling), modification of water regimes, entry of invasive species, impacts from fisheries and other harvesting activities, water pollution and eutrophication, and shifts due to climate variability.

It is critical to point out that technology allows partial substitution of some water ecosystem services. For instance, water purification can be partially substituted through the construction of water treatment facilities. Yet, protecting watersheds to enable ecosystems to provide this service, creates the conditions for the conservation of other services such as the maintenance of fisheries, the reduction of flood risks or the protection of recreational and amenity values.

3.1.5 The economic value of environmental benefits from EPIs

One of the purposes of the assessment framework, based upon the state of the art and outcomes from WP3 *ex-post* studies, does actually consist of determining the whole list of different potential benefits.

Amongst the many ways in which water policy can affect the environment, an important clarification concerns to, what the most relevant benefits for the purposes of EPI-WATER are. The question arises because we are mostly interested in assessing instruments rather than water policy goals. In other words, EPIs are to be considered an option for water management provided they could make a better contribution to water policy when compared to other available alternative instruments. Many of the relevant arguments to test such hypothesis belong to the criteria analysed in other sections of this assessment framework (such as the analysis of transaction costs, cost effectiveness, social justice or political acceptability), and for which information on the environmental benefits and costs are clearly relevant.

In addition to that, for the sake of identifying benefits, our focus will not be on the value of the environmental services associated to a certain status of water-related ecosystems conservation (as this status is the concern of water policy objectives), but rather on the differential environmental benefits of using a particular EPI rather than its best available alternative. The most relevant question is then what difference in terms of environmental benefits will make using EPIs from the set of measures selected to obtain a particular water policy goal.

The list of potential benefits to be considered can be organized according to the following general categories:

1. Avoided opportunity costs of achieving a pre-determined environmental target. Being just one of the different measures with the potential to achieve a given environmental target, a potential benefit of EPIs is the avoided cost of the best feasible alternative (either another EPI or, for instance, command-and-control solutions). Within this analysis it is assumed that society is committed to a certain status of water bodies, such as in the European Union once the WFD came into force. The analysis of this kind of benefits will make it possible to draw a clear link to the economic assessment (see Task 2.4.), in order to compare the different instruments on cost-effectiveness grounds.

2. Avoided opportunity costs of reducing pressures over water resources. Natural capital can substitute human-made capital in providing some water services. This is why the improvement in the quality of water assets might lead to remarkable economic benefits. The increase in water flows might also soar the natural assimilation capacity of a water flow as well as coming out with a reduced cost of treating effluents in order to guarantee a pre-determined quality standard.

3. Avoided costs satisfying the demand of water services in the economy to obtain a given output. This is the case, for example, of pumping cost-savings resulting from higher phreatic strata, reduced pre-treatment costs for drinking water provision, or increased biological potential for fishing production. This is also the case of fertilizer cost savings due to the use of regenerated water for agriculture.

4. Benefits associated to the environmental services associated with a better conservation status of water resources. These services include:

> a) Reduced drought risk, as the likelihood of a severe deficit in water availability over water demands is reduced, and higher drought resilience as buffer stocks are now improved and water allocation is contingent to water supply.
>
> b) Improved flood protection, should floodplains be better protected, and disaster risk reduction as a result of lower vulnerability for people and real estate, and wise management of land and the environment.
>
> c) Reduced health risk, as the likelihood of a decrease in morbidity or premature mortality rates, derived from exposure levels to water pollution.
>
> d) Recreation and other amenities, as the consumptive (i.e., angling) or non-consumptive values (i.e., bird spotting) related to leisure opportunities linked to a good ecological status of water bodies and ecosystems.

3.4 Indicators

The work on indicators to assess the environmental outcomes of EPI implementation will build upon the roadmap presented in the introduction (see Figure A.2). Assessing the impacts on a water body requires some quantitative data to describe the drivers of the demand for water services, the uses of water services, the pressures on water ecosystems and the status of the different water bodies.

Regardless of the process to be adopted, the assessment may require a conceptual understanding of what actually drives impacts. At its simplest, this can be that if an effluent is discharged to a lake, for instance, there is likely to be at least a local impact in water quality parameters (an increase of pollutant concentration), which will need to be measured. The impact of an EPI implementation, if aimed at discouraging more discharges, would thus need to be measured against the business-as-usual scenario. Often, a simple approach would be suitable to assess the impact of a pressure and the EPI designed to weaken its negative influence. However, things might be more complex, given the range of catchment types, water bodies, interacting pressures, process conceptualization, data requirements, and scope of impacts,[14]

Thus, indicators for the assessment of environmental outcomes of EPIs will definitely need to be linked to drivers (an anthropogenic activity that may have an environmental effect, as previously described), pressures (the direct effect of the driver), the state of the water body (the condition resulting from natural and anthropogenic factors), impacts (the environmental effect of the pressure), and responses (the measures taken to improve the state of the water body). Sometimes the distinction is not necessarily clear. For instance, state and impact separates effects that are sometimes combined (or even confused); since many of the impacts are not easily measurable, state is often used as an indicator of, or surrogate for, impact.

Driving forces are, as a matter of fact, sectors of activity likely to exert pressures on water-related ecosystems. They can be a diffuse pollution source, a point pollution source, (surface and groundwater) water abstraction activities, the artificial recharge of aquifers, and activities inducing changes in the morphology of water bodies. As a result of that, pressures (the direct effect of the driver; whatever that could directly cause deterioration in the status of a water body) can either be point or diffuse source discharges of pollutants, water abstraction flows, effects on water flow regulation, morphological alterations, and recharge flows of groundwater resources. At the end of the day, these pressures are relevant because they will be affecting the state of water bodies (that is, the condition of water bodies resulting from natural and the above-mentioned anthropogenic factors), both in terms of physic-chemical, biological, and morphological characteristics. These impacts (changes in the water state as a result of pressures) can be very diverse but can easily be categorized taking state indicators as a starting point (See Figure B-3).

[14] This is very relevant within the context of the River Basin Management Plans 2009-2015.

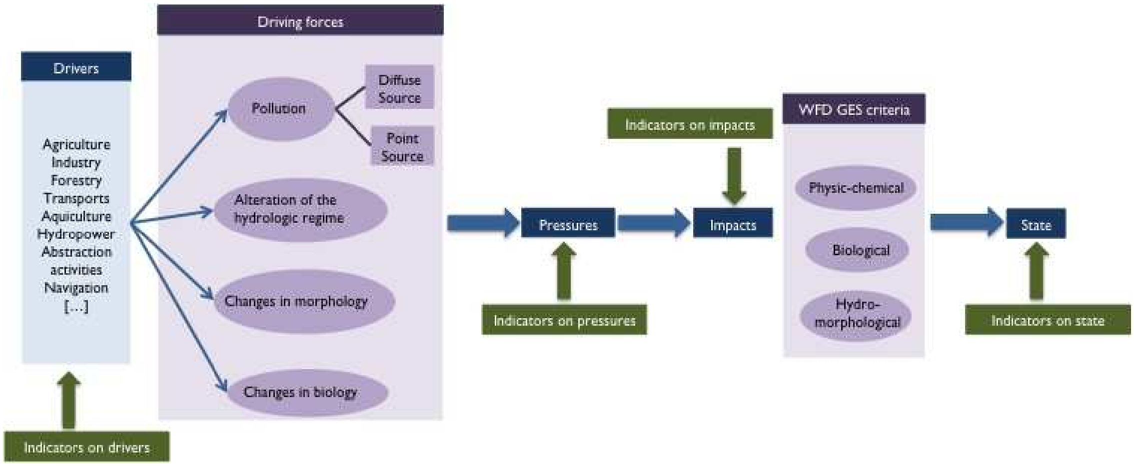

Figure B-3. Scheme on indicators as suggested by EEA (2003) and WATECO (2003) (Source · Own elaboration on the basis of EEA (2003) and WATECO (2003))

It is clear that whilst the existence of a driver implies, in almost all cases, the existence of a number of pressures, a pressure does not necessarily always relate to an impact. An exception is that of diffuse pollution, where driving forces are not always directly related to pressures but pollution reaches water bodies on hydrologically driven pathways.

On the basis of these three groups of indicators (drivers, pressures and state), *ad hoc* indicators for impacts and responses should also be developed for the assessment of environmental outcomes of EPIs.

IMPRESS (WATECO, 2003b)[15] aims at guiding experts and stakeholders in the implementation of the Directive 2000/60/EC (WFD) providing a comprehensive guidance document to identify drivers and pressures and to assess impacts on water bodies. It focuses on the analysis of pressures and impacts within the characterisation of water bodies according to Article 5 ("Characteristics of the river basin district, review of the environmental impact of human activity and economic analysis of water use"), in the broader context of the development of integrated river basin management plan as required by the Directive. It stresses upon the idea that both the spatial and temporal scales for the identification of indicators are of paramount importance. The spatial scale is especially relevant for the correct identification of pressures, which requires a consistent identification of relevant targets, their size and their vulnerability to be impacted. Regarding the temporal dimension, it is important to recognize that some pressures may result in impacts many years in the future, as well as noting that some future impacts might relate to past pressures that no longer exist.

[15]IMPRESS is a working group dedicated to the identification of pressures and assessment of impacts within the characterisation of water bodies according to Article 5 of the EU WFD (2000/60/EC). The guidance addresses the second requirement of Article 5, which refers to "a review of the impact of human activity on the status of surface waters and groundwater". For the purposes of EPI-Water, this review has to be integrated with the economic analysis (WATECO, 2003a).

Closely linked to the efforts under IMPRESS, the UK technical advisory group on the implementation of the WFD (UKTAG), also developed the so-called "reference conditions" for each surface water body and collated and validated information for them. This is a quite in-detail characterization exercise, including both an outline of the approach to developing reference conditions and the type descriptions themselves, for lakes, rivers, and transitional and coastal waters.

Both IMPRESS and guidance documents on reference conditions developed by some EU member states, provide indicators for impact assessment for biological, hydro-morphological, and chemical and physic-chemical quality.

IMPRESS is to a large extent based upon the DPSIR [drivers, pressures, state, impacts, responses] framework of environmental indicators (developed by the EEA), and the WFD (Gabrielsen and Bosch, 2003). The report includes descriptive indicators (for state, pressures and impacts); performance indicators, to measure the gap between the current environmental situation and the desired one (target); efficiency indicators (relating drivers to pressures), shedding light on the efficiency of products and processes in terms of resources, emissions, and waste per unit output; policy-effectiveness indicators, relating the actual change of environmental variables to policy efforts; and total welfare indicators. EEA (2010), for example, includes the assessment of freshwater quality in the European Union. That report assesses various detrimental impacts of poor water quality on freshwater ecosystems.

The OECD developed the DPR framework that was ulteriorly adapted by the EEA to the DPSIR. The OECD publishes reports on environmental indicators, including some indicators related to freshwater resources (OECD, 2008). The report includes an indicator on wastewater treatment, which shows the percentage of the national population actually connected to public wastewater treatment plants (the extent of secondary and/or tertiary treatment provides an indication of the efforts to reduce pollution loads; also, information is provided on the intensity of use of freshwater resources, expressed as gross abstraction *per capita* as percentage of total available resources and as a percentage of internal resources).

Last but not least, it should be clear that indicators have not only been developed as isolated sets of data or *ad hoc* efforts to enrich information on driving forces, pressures, states, impacts and responses of water ecosystems. A more integrated approach has been followed with the amendment of conventional national (macroeconomic) accounting systems. The implementation of the WFD has led to an increase in the demand for water-related data, for further comparability across countries, and the availability of data, and a better integration of economic and eco-hydrological information.

In order to meet this growing demand, the possibilities of linking existing water information systems to the economic accounting system, previously investigated in the Netherlands (de Haan, 1997; van der Veeren et al., 2004), resulted in the creation of the National Accounting Matrix including Water Accounts (NAMWA), which is based on the system of integrated environmental and economic accounting (SEEA), and also of the SEEAW (UNSTATS, 2007), which is the object of Task 4.4. within EPI-WATER.

Beyond the four layers of indicators that have been identified, an additional one would be welcome on ecosystem services. A relevant question is whether these services are associated to water policy goals (in that case, they are beyond the scope of the project), or rather depend on the specific instrument to be used (in this case, they have to be analysed). As in Table B-1 (section 0, additional material), these are provisioning, regulating, cultural, and life supporting services.

3.5 Demonstration example of the assessment of environmental outcomes: voluntary agreements for environmental services in the river Ebro (NE Spain)

3.5.1 Brief description

The poor ecological status of heavily modified rivers can be explained by increasing pressures from water abstractions, gravel mining, canalization, and pollution discharges as well as by the successive modifications in the river morphology (Batalla et al., 2006; Zawiejska and Wyzga, 2009; Ollero, 2009). Restoring the ability of river ecosystems to provide basic environmental services can only be obtained at the cost of impairing the ability of water infrastructures to provide valuable socioeconomic goods and services, as hydropower, water supply, flood control and amenities (Bednarek and Hart, 2005; Robinson and Uehlinger, 2003). This explains the increasing interest in learning how to balance river rehabilitation benefits with the provision of goods and services by water infrastructures.

The large dams of Mequinenza and Ribarroja built back in the 1960s modify the hydrology of the lower Ebro River. Amongst other hydrological components, flood magnitude and frequency have been altered. Although the river still experiences natural floods and the impact of regulation is much smaller than that found in comparable large rivers such as the Sacramento and the San Joaquin in California (Kondolf and Batalla, 2005), and even in some of its main tributaries (Ollero, 2009), the river's physical and environmental conditions have remarkably changed in the last decades.

3.5.2 The economic policy instrument to be assessed

In 2002, after two extremely dry years, the hydropower company, the water authorities, and the scientific community coordinated efforts to establish and promote a voluntary agreement, which jointly considers the possibility of compensation to the hydropower utility in exchange of water delivery, producing flushing flows as a means to control and remove the excess of macrophytes (visible algae and other flora species)[16] from the river channel. This has been performed twice

[16] Macrophytes are beneficial to lakes where they are considered as eco-indicators, but in heavily modified rivers its presence is an evidence of degradation, rather than good ecological status.

a year (at the end of spring and autumn) providing a testing scenario for the increasing improvements in its design in order to enhance its effectiveness reaching removal rates.

3.5.3 The assessment

a) Behavioural model

From the company's perspective, a mixture of natural and human-made capital assets composes the reservoir and its associated power generation facility. At any time, the operating company decides on the energy flow to be produced, taking account of the given technical specifications of the plant, current operating rules and the expected evolution of the amount of water stored in the reservoir and of energy price projections. From a private business perspective these decisions aim at maximizing the value of the expected flow of benefits along the entire life span of the reservoir (eventually over an infinite horizon). As the electricity produced cannot be stored for its future selling, the profit-maximizing company can be assumed to simultaneously make two kinds of decisions: choosing how much water to use every day, and choosing how to distribute the daily water used along the day.

As a result of the implementation of the EPI, the hydropower company has to face another constraint when deciding on the daily amount and distribution of water. Since 2002, the company has to free a specified amount of water in certain days and at certain hours for macrrophytes removal, which may increase its financial revenue that day as well as diminishing water stocks that otherwise could have been used in price-peak hours. Since the flushing flow implies a deviation from the optimal decision profile, the overall effect on expected financial profits and revenue might be negative and the opportunity cost might then be positive..

b) Effectiveness of the EPI

The implementation of the EPI in the Lower Ebro started in 2002 after two dry years (corresponding to one of the most remarkable mycrophyte bloom ever, URS, 2010, p. 77), which created the necessary context to begin co-operation between the hydropower company, water authorities and the scientific community. Since then and with the exception of the years 2004, 2005, 2008 and spring of 2009, flushing flows have been regularly performed and have resulted in macrophytes removal rates as high as 95% in areas close to the dam (Batalla and Vericat, 2009).

The efficiency of flushing flows in macrophytes removal depends on the amount of macrophytes, natural flow variability, and macrophyte life cycle. For example, removal rates are considerably higher during autumn than during spring, when macrophytes are growing and stalks are stronger (according to the macrophytes life cycle, macrophytes mass reaches its peak in summer) (URS, 2010).

Artificial floods have proved themselves a useful means to maintain the river ecosystem, with the highest macrophyte concentration after years where flushing flows were not implemented (ERBA, 2010). However, removal rates have been reduced both in intensity and extension since 2002, demonstrating that flushing flows with its present design are not enough to keep macrophytes under control in the long term. Alternative systems such as new designs of artificial floods and the use of mechanical tools are being considered to avoid macrophytes proliferation in the long term (URS, 2010). It is interesting to note that water quality has remarkably been improved over the last few years, although the amount of water and the hydrological regime have not: as a result, macrophytes are very healthy.

On the other hand, flushing flows are also tested means to enhance biological productivity of the physical habitat, to entrain and transport sediments for the restoration of the river channel, to remove pollution loads and improve the water quality, to control salt intrusion and to supply sediments to the delta and the transition waters (ecotones) (Batalla and Vericat, 2009).

c) Pressures and impact assessment

The Ebro River Basin does not show the structural quantitative problems distinctive of many Mediterranean and Central and Southern Spanish river basins, although the hydrology in the last years has been modified and shows a trend towards rainfall and runoff decline; in fact, the reduction in long-term average annual runoff from the period 1940-2006 to the period 1980-2006 is 21.55% (ERBA, 2007). This pattern is also observed in the Lower Ebro, which in addition has a significant rainfall and runoff variability that makes the area especially vulnerable to extreme events, as compared to the rest of the basin (AEMET, 2011).

The EU WFD (2000/60/EU) has defined the precise objectives for the correction of negative impacts of previous river management patterns and has clarified methods and concepts for the assessment of river restoration measures and programs (Bratricht and Truffer, 2001; Ruef and Bratricht, 2007). When dealing with the so-called Highly Modified Water Bodies, the objective of water policy is to recover the best feasible ecological status, and the measures that can potentially contribute to this target need to be assessed on the basis of both their own cost effectiveness and their potential benefits for the economy (WATECO, 2003a).

Likewise, research in biology and ecological engineering (Granata and Zika, 2007) shows that dams and other infrastructures, which alter river systems, can also be used as tools to artificially reproduce some of the functions performed in the past by the natural system. Channel maintenance flows together with sediment injections downstream can effectively restore the sediment balance altered by a reservoir (Buer, 1994; Kondolf, 1997). Similarly, modifying hydropower dams operation rules to guarantee the recurring release of properly designed flushing flows may effectively replace the role performed in the past by the natural floods distinctive of many Mediterranean rivers which served to maintain the structure and functions of the river ecosystem (Hueftle and Stevens, 2002; Vinson, 2001; Kondolf and Wilcock, 1996). Since the implementation of flushing floods there has been an improvement in the ecological status of the river stretches close to the dam.

d) Economic valuation of environmental outcomes

Public expenditure not based on actual social willingness to pay (WTP) can be justified on the basis of the precautionary principle in cases when the expenditure is aimed towards avoiding irreversible effects on natural assets (Bishop, 1978). On the other hand, when this expenditure maintains or increases the supply of goods and services for the population needs over safe minimum standards for habitat preservation, expenditure is not justified without social profitability or a positive cost-effectiveness assessment (Norton, 1987). For this case study, river alteration is actually relatively low and there is no irreversibility; hence, social profitability is also required.

The artificial floods require 36 million cubic meters along 16 hours, which implies a cost of EUR 76 000 in the autumn flood and EUR 33 000 in the spring flood. Hence, under the actual scheme flushing flows have an estimated cost of EUR 100 000 per year (own elaboration), compared to the estimated daily revenue of the company of EUR 250 000 (thus, losses mean only 0.16% of the average yearly revenue) (own elaboration). For the measurement of benefits, several methodologies can be applied, such as contingent valuation, travel costs, hedonic prices, and choice experiments (environmental valuation) or multicriteria analysis, although their cost (time, money) would be too high for our purpose here and there still would be doubts about the convenience to use these valuation techniques in such a case study. Nevertheless, there exist a number of environmental valuation studies on river restoration in highly modified rivers, which can give us a range of the expected willingness to pay for river restoration programs such as the one herewith assessed, following a *sui generis* meta-analysis procedure which is adequate for the purposes of this *ex-post* assessment.

According to these studies, WTP ranges from 11 USD/year per person to 377 USD/year per person. Even from a narrow perspective and considering that ecosystem services were to be paid for only by the local population of 191 568 inhabitants (which is not necessarily the case), the average cost would be only 0.52 €/year/person, which is considerably lower than the total WTP estimated by all the studies. On the contrary, should river restoration measures be paid by the million people living in areas close to the Ebro River, the cost would fall to 0.1 €/year per person; 0.01 €/year per person if taking the whole river basin as a reference (10 million inhabitants).

3.6 References

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3.7 Additional material

Table B-1. Water ecosystem services[17]

Class	Ecosystem Service	Description
Provisioning	Food	Biomass production: fish, wild game, fruits, grains, etc.
	Freshwater	Storage and retention of water for domestic, industrial and agricultural uses
	Fibre and fuel	Production of logs, fuel wood, peat, fodder, etc.
	Biochemical (biological products)	Extraction of materials from biota
	Genetic material (biological products)	Medicine, genes for resistance to plants pathogens, ornamental species, etc.
	Biodiversity	Species and gene pool
	Abiotic products	Extractable and non-renewable raw materials such as metals, stones, gravel
Regulating	Climate regulation	Greenhouse gases (i.e. carbon fixation in histosoles), temperature, precipitation, etc.
	Hydrological flows (water regulation)	Groundwater recharge and discharge; storage of water for different uses (surface water runoff)
	Pollution control and detoxification (water purification)	Retention, recovery and removal of excess nutrients and pollutants
	Pest regulation	Invasive or pest species
	Erosion	Retention of soils
	Natural hazard	Flood control, storm protection, droughts
Cultural	Spiritual and inspirational	Personal feelings and well-being
	Recreational	Opportunities for recreational activities
	Aesthetic	Appreciation of natural features
	Educational	Opportunities for formal and informal education and training / and for non-commercial uses (i.e. archaeological values, knowledge systems)

[17] An important question is whether these services are associated to water policy goals or they rather depend on the specific instrument to be used; if the former, this is not to be analysed in EPI-WATER, in the latter, it will.

Class	Ecosystem Service	Description
	Conservation	Existence values for species and biodiversity.
Supporting	Soil formation	Sediment retention and accumulation of organic matter
	Nutrient cycling	Storage, recycling, processing and acquisition of nutrients
	Pollination	Support for pollinators
	Primary production	Aquatic vegetation for wildlife
	Habitat	Habitat for fishes, avifauna, mammals, etc.

Source: Own elaboration from MEA, 2005 and Hearnshaw, et al., 2010.

List of illustrative indicators for the quantification of water ecosystem service flows:

- Food production: (fish) catches, fruit harvest, crop yield, etc.
- Freshwater provision: volume of water for irrigation, volume of water for industrial uses, volume of water for domestic uses, volume of turbined water for power generation, etc.
- Fibre and fuel: canopy cover fraction; forest occupation rate; forest area; volume of logs, fuelwood, peat, and fodder; forest potential biological productivity; rotation coefficient; annual increase in overbark volume; etc.
- Biochemical: output of materials from biota.
- Genetic material: active principles from biological resources, genes for resistance to plants pathogens, output of ornamental species, etc.
- Biodiversity: species richness, Simpson's index, Shannon-Wiener index, Berger-Parker index, Rényi entropy index, evenness, etc.
- Abiotic products: output of metals, stones, gravel, etc.
- Climate regulation: carbon fixation in histosoles, soil organic carbon content, wetland age, etc.
- Water regulation (hydrological flows): groundwater recharge and discharge rates, water stored for different uses, surface water runoff, etc.
- Pollution control and detoxification (water purification): rate of retention, recovery and removal or excess nutrients and pollutants.
- Pest regulation: number of individuals of invasive or pest species.
- Erosion: sediment yield at reservoirs, actual soil loss, potential soil loss, etc.
- Natural hazards: number of storms, intensity of storms, frequency of rainfall, drought level, number of floods, etc.

- Soil formation: rate of sediment retention, organic matter content in soils, etc.
- Nutrient cycling: nutrient content, etc.
- Pollination: number and diversity of pollinators, pollen yield, etc.
- Primary production: net primary productivity of aquatic vegetation for wildlife, etc.
- Habitat: number of habitat for fishes, avifauna, mammals; habitat quality indexes, etc.

4. Economic Assessment Criteria

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4.1 Introduction

The main objective of this section is to develop the economic assessment criteria in the context of WP2, by building on the DoW definition: "The guiding principles and criteria of the economic assessment will depend on the scope of the analysis and the ultimate goal for policy identified in previous tasks. The assessment may rest on:

- economic efficiency principle, based on a cost-benefit rationale (both costs and benefits are estimated in a total economic value perspective, hence including both use and non use values, and, from a different perspective, both private costs/benefits and externalities);
- cost/effectiveness principle under which the benefits need not to be monetized;
- criteria related to distributional and equity effects of proposed policies (that is who benefits from and who bears the burden imposed by the policy instruments);
- cost recovery, revenue generation and promotion of innovation; risk reduction / avoided damage" (EPI-WATER DoW, 2010).

The different economic criteria can be used to quantify different (and complementary) economic aspects in the performance of EPIs, e.g. they are delivering different information and are not substitute of each other. As a consequence, there is no priority among economic criteria.

The preferred combination of economic criteria to be used in each case will depend on the specific policy issues (objectives) and related to the decision making process. Besides definitional issues, we also try to discuss the different information content of each criteria, its advantages, disadvantages and limitations. Finally information needs in relation to data availability are considered, as they are relevant determinants of the ability to qualify each criterion and hence the practicability of its use in the policy assessment process.

It is well recognized in the literature that the implementation of water policy and the incorporation of economic criteria in policy design and implementation is a quite difficult task; as Rogers et al. (2002) states: "… the promotion of equity, efficiency and sustainability in the water sector and water pricing is probably the simplest conceptually, but maybe the most difficult to implement politically". A sound use of economic criteria needs to take into account such difficulties and limitations.

Economic criteria derive mainly from the literature concerning project evaluation and economic policy evaluation. These economic criteria are seen as a partial component of information needs to assess a policy making process and, for the aim of the project, as a component of policy relevant information necessary to study the performance of EPIs either ex-ante and ex-post (WP3, WP4). The assessment process, as it is well known from the literature, can include a large set of considerations about the consequences of the alternative courses of action, including effects upon the environment, the economy and people (Stiglitz 2009).

Hence, economic criteria will not be regarded as the only or the final criteria for EPIs' performance. The final users of policy information are the stakeholders, the general public and the relevant administrative bodies. Public consultation and social agreement on water resources management are relevant requisites for an EPI's implementability and sustainability. Decision makers will mediate economic criteria with other criteria, particularly when EPIs raise issues such as social/equity concerns, public goods etc. This also means that projects/policies with a negative net economic benefit could be actually implemented nonetheless, if this is justified by other considerations. However, we do not address these issues here, except when we comment about the information content and usability of specific economic evaluation parameters.

Economic criteria for the evaluation of EPIs can be better understood/used against the main water policy objectives. Some broad policy objectives are available at the EU level. For example in the context of the policy objectives about the environment and natural resources, at the beginning of 2011, the EU Commission published a document about resource-efficiency in Europe (EU, 2011) which gives some background about efficiency in the use of water as a general policy objective. The WFD itself identifies general policy objectives and instruments to achieve them. More commonly, and in accordance with the WFD, policy measures' objectives are defined locally and contingent to specific interventions. Nevertheless, some general principles (such as general economic efficiency, costs recovery, full costs consideration, etc.) can be regarded as economic criteria of relevance, in principle, for all instruments and areas in the context of the WFD.

For the purposes of this task we consider three main approaches to (or components of) the use of economic criteria:

1. Efficiency estimate as an overall aggregation criterion;
2. Economic information as one or more partial criteria in the evaluation framework;
3. Economics of policy mechanism.

Each of these three approaches will be treated as a sub-section of section 3 of this chapter.

In particular, the overall aggregation criteria section will consider the more general and global economic assessment based on the efficiency criterion which, generally speaking, compares the value of resources used with the value of resources produced in a process. This general principle can take the form of the net benefits maximization either in a static context or in a dynamic/intertemporal setting, the latter taking the form of the net present value (NPV). It aims to strike a balance between costs and benefits and to evaluate if a project (measure or policy) provides a net social benefit. In this part, the cost-benefit analysis (CBA) will be explored as a method to provide such comparison of costs and benefits; different levels of completeness of the components will be described in order to examine how to deal with incomplete and/or unreliable economic estimates.

Subsequently, in the section about economic information as a subset of criteria, all those criteria that are partially able to asses only some defined and precise components (in particular costs of a measure) will be considered. In this part the following will be included: a) cost/effectiveness criterion which uses the criterion of cost minimization against an equal outcome; b) criteria related to distributional effects e.g. how policies affect the economic situation of different individuals or groups; c) risk reduction/avoided damage through the economic value of potential (negative) uncertain events; d) promotion of innovation (as a major issue connected to the dynamics of policy effects).

The last direction is about policy mechanisms among which we consider the cost recovery/revenue generation i.e. the ability of the instrument to cover the costs incurred for the provision of a given service or policy costs, incentive compatibility and asymmetric information.

4.2 Typology

Different typologies of costs and benefits are relevant for economic analysis, at different levels of detail. Some major distinctions can be recognized in the following categories:

1. Financial, opportunity and environmental costs;
2. Internal and external costs (either environmental or not);
3. Emerging cost vs. foregone economic benefits (i.e. opportunity costs in a wider sense);
4. Use values vs. non-use values;
5. Intended effects vs. side-effects

A component to have in mind regards the relevance of opportunity costs in policy evaluation. Sometimes they may be substantial, for example when allocating water requires building new water transport facilities; sometimes they will be negligible, as for example letting water flow through a turbine in a hydropower plant. In any case, though, direct costs are relatively uninformative of the actual opportunity cost of EPIs and this is one of the real problems faced in policy evaluation. In addition there are some important opportunity costs hidden in the details of actors' behaviour or policy instruments, such as those associated to produce a constant flow of electricity along the day, to maintain minimum flows in the river, instead of producing all the energy at noon when the price and the demand are at its peak. When bargaining over water is allowed between different regions, sectors or water jurisdictions, the opportunity cost for those who sell water are covered by the compensation received; the indirect cost, however, of the reduction in the economic activity is not necessarily eligible for compensation. This is of particular concerns for unmovable production inputs, such as land (abandoning land in dry areas may increase erosion, soil loss and desertification risk, depopulation might threat heritage and increase the cost of providing basic services such as water and education to the few who will remain in rural areas) and is a matter of discussion for mobile factors.

Taking a more detailed perspective, economic analysis can be supported by a classification of costs and benefits, which, in turn, can be related to specific EPIs. Table B-6 reports examples of costs and benefits associated to specific measures.

Table B-6. Typologies of policy measures, benefits and costs

Measures	Benefit	Cost
Better water resource allocation (voluntary transfer of water rights)	Output increasing without increasing the overall use of water	Transaction costs, Management costs
Multipart tariffs for water	Decreasing of the overall environmental cost and releasing additional resources for more valuable water uses in the economy overall.	
Buying the land of people living in flood-prone areas	Higher economic benefit out of reducing risk exposure and improving flood control services provided by ecosystems	Transaction costs
Farmers with the right to sell water	Increasing the technical efficiency of irrigation systems, at the same time that more water is available for other uses, increasing the output without further deterioration of freshwater sources	Transaction costs
Compensating firms	Environmental services to restore river flows.	

Water markets in drought-prone areas: conversion of irrigated agriculture into a water buffer	Avoided costs of the best available alternative.	Transaction costs
Water market in irrigation district	Increasing the overall output compensating losers and avoid the monitoring and enforcement cost of the command-and-control alternative	Transaction costs, costs of production means
Multipart tariffs for drinking water	Reduce lower-value water demands and, compared to its best available alternative for the same target, it reduces the cost of providing the water service as lower-size water works and lower operational expenditures would be required.	
Restoring the minimum flows		Compensating hydropower companies

4.3 Assessment methods and techniques

In this section, different methods and techniques responding to the economic principles will be illustrated under the three main directions defined above.

4.3.1 Overall aggregation criteria

The more general and global economic assessment is based on the efficiency criterion which can be addressed using different approaches (and indicators) depending on:

1. The object of analysis: policy or project;
2. The components of cost and benefit;
3. The suitable optimization principles, that are also usable as proxies of the actual economic efficiency if an indicator of overall efficiency is not readily available or measurable.

The most popular methodology implementing the economic efficiency principle is cost-benefit analysis (CBA) based on the comparison of the costs and benefits of a project (INEA, 2009). The CBA is an ex-ante evaluation method used to investigate if a project meets the criterion of acceptability (feasibility) based on its profitability. Initially developed mainly for projects, CBA methods have been used also for policy evaluation, including rather wide issues (e.g. policies related to global climate change). The CBA can be done considering three points of view:

1. financial analysis based on the private (project proposer) point of view;
2. economic analysis based on the point of view the community/society as a whole;
3. social analysis based on the point of view of individual stakeholders and stakeholders' groups.

The main difference between financial and economic analysis regards the attribution of the net benefits of the project. The financial analysis only takes into account the monetary income earned by the investor, while, the economic analysis takes into account all the benefits that the whole society obtains, both the investor and individuals in general which, in a direct or an indirect way, are affected by the project (Nuñez-Sánchez, 2005). The social analysis somehow connects the CBA with social and equity concerns; see Section 5.

Different ways the CBA is implemented can be illustrated considering the historical evolution of the CBA in the evaluation of projects. This evolution had to consider the changing in the objectives of the development policies. There are three stages:

1. Traditional approach: a clear economic approach that aims to increase the level of welfare in monetary terms. This approach was applied until the late 1960s.
2. Socio-economic approach: arises when the concept of social equity is incorporated. The aim is to achieve equitable income distribution.
3. CBA with environmental externalities valuation is the third approach and results from the incorporation of environmental criteria that are relevant in the decision-making process.

In its widest application as an unique comprehensive synthesising criterion, the CBA can put together any effect that can be translated into monetary values, including environmental and equity (e.g. through weights for different social groups) concerns.

In the following, the reference point of view will be the economic analysis, as the most direct perspective concerning policy, which can be identified as a collective decision and action.

The CBA of a project can be developed in several steps (modified from Hanley and Spash, 1993):

1. Analysis of project objectives'/Identification of alternatives (including a baseline)/identification of time horizon;
2. Identification of project's effects;
3. Monetary evaluation of project effects;
4. Comparison between costs and benefits;

5. Judgment on economic feasibility.

It is well recognized in the literature that the steps can be formulated in several alternative ways. Also, while the stages listed above trace an ideal path for project evaluation, the decision making process is generally not linear and may consider at the same time the objectives and the means to achieve them.

At first, the CBA has to consider the setting of the decision problem, including the objectives of the project, the identification of alternatives and the time horizon of the project (step 1). The second step is the identification of effects (step 2) throughout the time horizon of the project. The effects of the project are expressed in terms of benefits and costs. The net benefits are the difference between benefits and costs, which represent the contribution of the project to social welfare. After the identification of effects, their evaluation can be made (step 3); in this stage, it is important that the prices system reflects the values assigned by society. The comparison (step 4) and the judgement on economic feasibility (step 5) are linked and depend on some indicators (NPV – Net Present Value, IRR – Internal Rate of Return, B/C ratio – Benefit-Cost ratio) which can be considered in the comparison process.

The NPV is the difference between discounted benefits and costs. If we let *t* be the indicator of the tie period from *1* (first year of the project) to *T* (last year of the project= time horizon) and given a series of benefits B_t and costs C_t, then the NPV is defined as:

$$NPV = \sum_{t=1}^{T} \frac{B_t}{(1+q)^t} - \sum_{t=1}^{T} \frac{C_t}{(1+q)^t}$$

where $1/(1+q)^{t}$ represents the discount factor and q the discount rate.[18] The criterion for project acceptance is to accept only if NPV>0. If the choice is between two projects, the project with the higher NPV guarantees the highest economic return. The NPV indicator has some limitations: a) it supports larger projects because they give a higher NPV and b) it depends on the discount factor used. This second point is quite important; in fact, when the discount factor is equal to zero then NPV is the simple difference between benefits and costs, but when the discount factor increases then the NPV decreases. In spite of these limitations, the NPV remains the reference parameter in CBA.

The IRR is the discount factor yielding NPV = 0. In Figure B-5, the IRR for the project A is s_A and for the project b is s_B. The criterion for project acceptance is to accept if the IRR is higher than a reference discount factor (representing the expected profitability from the investment).

[18] There are several problem in the discount rate identification even if its selection is important. Economic theory has actually struggled to identify a single and theoretically correct value, or to go from theoretically valuable principle to numerical values. Often, governments set “conventional” discount rates for use in public policy appraisal.

The B/C ratio represents the unit net benefit: B/C > 1 means than the discounted benefits are higher than the discounted costs. Some limitations of B/C ratio consists in a) its identification depends on the classification into costs and benefits (sometimes it is not so easy to distinguish) and b) it is not possible to use it in direct projects comparisons (except for ordering of several project potentially implementable) because the B/C ratio itself does not lead to maximize the total social welfare.

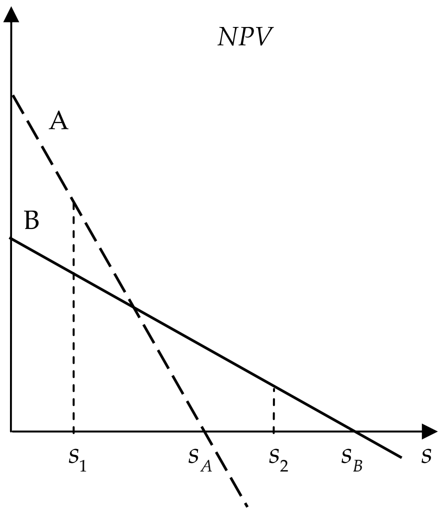

Figure B-5. Relation between Net Present Value (NPV) and different discount rates

The consideration of a single evaluation parameter is not necessarily able to make a judgement about the project feasibility. Altogether, while the literature emphasises that the CBA analysis has a large number of disadvantages and problems (linked to the reliability of indicators, the need to provide a monetary evaluation of each benefit/cost item and the discount rate definition), it still remains a reference method for evaluating projects or policies.

4.3.2 Economic information as a set of partial criteria

In this section, selected economic information that can be used as a form of partial criteria will be discussed, in particular with reference to components of the costs of a policy measure.

Cost/effectiveness principle

The cost effectiveness principle is considered as one of the partial criteria because it is based on the evaluation of the costs, and not of the monetary value of benefits. In fact, it can be considered as a relaxed CBA, which benefits are not measured, leading to the concept of cost effectiveness analysis (CEA). Using the CEA, the evaluation of the benefits can be avoided, skipping some of the difficulties in the economic estimation of benefits related to water resources.

The criterion is based on the costs minimization principle on equal conditions, such that between two or more alternative actions that produce (at least) the same benefit or result, the action chosen will be the one that has a lower cost.

Under conditions of budget and time limitations, the CEA is more feasible than CBA; the two main indicators of the CEA, which are based on a mix of economic and physical characteristics, are:

- the cost per each unit of result: the ratio between costs and effects of the project/policy;
- the result per each unit of cost: the ratio between effects and cost of the project/policy.

Cost-Effectiveness Analysis, together with Cost-Benefit Analysis is the main method for the economic evaluation of water programmes. Within the context of the WFD, the most widely accepted method is CEA, because it allows the outcomes of a programme to be measured in terms of physical units. From a practical perspective, CEA should be used to select combinations of measures that allow the desirable ecological objectives to be attained at the lowest costs.

In addition to the generic indicators listed above, regarding the evaluation of projects/policies concerning water, the literature proposes several indicators, which can be mostly seen as a modification of the previous ones. In the context of the measures for a water use reduction, the general net present cost is modified introducing the levelized cost (White e Howe, 1998; Fane e White, 2003; Fane et al., 2003). In particular this approach is used in the project evaluation regarding production/saving of resource such as energy and water. The method returns a unit cost of produced or saved resource. For this reason, this indicator is rather useful in the comparison of projects aimed at resource conservation.

Within the framework of the cost-effectiveness principle, several other indicators can be included, that have in common the fact of relating some economic performance with a physical unit of resource use. Some examples are performance indicators related to irrigation systems, as can be seen in Garcìa-Vila (2008):

- Water Productivity (WP) in €/m3 represents the value of agricultural production per unit water used;
- Irrigation Water Productivity (IWP) derived by (Malano e Burton, 2001) represents the added value of irrigation through the increasing of agricultural production per unit of water used;
- EvapoTranspiration Water Productivity (ETWP) represents the agricultural production value for each evapotranspiration water unit.

The reasoning of the cost/effectiveness principle has to consider two aspects: i) the actual objectives of water policy to which the implementation of EPIs contributes and ii) the alternative instruments to reach that objective. On this basis, EPIs are to be preferred should they allow reaching the prescribed social goals at a lower opportunity cost. On the other hand, one of the main claims in favor of EPIs is that they would be able to increase the efficiency with which water services are allocated over the entire economy, which is a powerful way to make the preservation of the water environment compatible with maintaining and increasing economic welfare.

An important caveat to bear in mind is that, different from command-and-control options, that are more intensive in known direct and administrative costs, the performance of incentive-based options depend more on transaction, indirect, and institutional costs (fines are less costly than deterring and continuous monitoring to prevent bad behaviour, provided moral hazard and enforcement costs are ignored). Thus, a proper assessment cannot be performed if relying only on direct costs; information requirements to put incentives and prescriptions in the balance are more stringent than simple cost-benefit analysis at a project level. On the other hand, all these costs are much more difficult to assess in practical policy evaluation than direct costs, which means that having to rely on incomplete evaluations is commonplace for EPIs.

Distributional effects

In literature, the concept of distributional effects is linked to equity. However, because of the different nature of the two concepts, the equity issue will be illustrated in Section 5. In this part only aspects concerning the economic distribution effects will be considered. In line with the examples, the studies on distributional effects of EPIs are usually motivated by one of two different reasons: i) to better understand the impacts on particular stakeholder groups in order to assess their responses or ii) equity concerns (which of course requires a definition of an equity concept, not treated here).

In the perspective of distributional issues two approaches will be presented: a) one focuses on the estimate of a measure of the inequality of distribution; and b) the other focuses on accounting of inequality in the water tariffs.

The point a) is addressed based on the Gini indicator that is the most popular approach in the evaluation of inequality of a distribution. The realms of application concern the evaluation of the income and wealth distribution. In the context of water policy evaluation, there are some examples of the use of the Gini indicator for the comparison of several price systems, under the hypothesis of introduction of different rate structures on consumer (Rawls et al. 2010). In addition to the Gini indicator, a graph (Lorenz curve) can be designed to represent the degree of inequality. In the paper, the authors plot the relative Lorenz curves for a specific water rate structure, mapping for example the proportion of water use by different customer income groups against the proportion of utility revenue collected from these income groups. Each Lorenz curve is compared with the perfect equity distribution line, where each customer income group contributes equal shares to the total utility supply and the total revenue. All Gini coefficient values are numbers between zero and one, and the lower the coefficient, the more equitable a rate structure is. A Gini coefficient of zero represents a perfectly equitable distribution.

A second approach (b) used to evaluate the distribution and welfare effects is to estimate the equivalent variation (EV) based on Marshallian demand function. An example is provided by the study of changes in block price systems related to household uses (Ruijn 2009). The EV measures the “amount that a consumer would be indifferent about accepting in lieu of the price change” and it is a proxy of an ex-post utility. The object of the study is to evaluate the impact of alternative pricing policies on the basis of households demand, welfare and distribution effects of changing water prices. The concern for the distribution of welfare effects in this case comes from the evidence that poor households use a large part of their income in the water bill even if the richer households have an higher water bill. The comparison between the flat system and a progressive block price shows the expected result: for the richer the better solution should be the adoption of a flat pricing system while for poorer the block price systems is preferred. Consequently, if there is no accounting for the inequality aspect, the social welfare is highest in a flat price system but, when inequality is accounted, then the block progressive price system shows better effects on poverty and welfare.

Risk reduction and avoided damage

Risk reduction and avoided damage can be considered as another partial criteria for economic evaluation of EPIs.

The risk issue recalls uncertainty and, in the environmental economics literature, it is connected to the option value, which can be considered as the insurance premium that a risk-averse individual is willing to pay to maintain resource for future use. Because of the nature of the water resource, the uncertainty about its use is an intrinsic characteristic.

In the context of environmental economics the risk evaluation is not well defined; in fact, only the approaches relying on the simplification of the problem based on the use of probability distributions are well defined and widely used (Costanza and Cornwell 1992, Crowards 1996).

The evaluation of uncertainty in supporting decision-making for environmental policy has been studied by the US Environmental Protection Agency (EPA). In this case the main question is not about avoiding the uncertainty but it is about its accounting. Furthermore, the uncertainty is one of the aspects to consider in the communication process between evaluator and policy makers.

EPA identifies several steps in uncertainty analysis. The analysis starts with the preliminary description of the future action in terms of present outcomes or conclusions based on expected or most plausible values; then a description of all known key assumptions, biases and omissions follows, leading to perform the sensitivity analysis on key assumptions (and justify the assumptions used in the sensitivity analysis).

In several cases, the outcome of the initial assessment of uncertainty may be sufficient to support the policy decision process. If the preliminary description is not enough detailed and sufficient, then more complex analyses (decision tree, Delphi-type method, meta-analysis and probabilistic methods) have to be used (Brouwer, 2005).

The risk and uncertainty are sometimes related to the cost-effectiveness of programs of measures to improve the surface water quality (Brouwer and De Blois 2008). The estimation of uncertainties is based on a combination of statistical assessment and expert judgement using different assumptions about the statistical distribution of these uncertainties.

One way risk is considered in economic valuation is through the assignment of economic value to uncertain negative events. In this case, risk is commonly defined in economic evaluation as the product of the damage brought by a negative uncertain event times the probability of its occurrence. In this case, one approach is to treat the possibility to reduce the risk or to avoid damages as an estimate of the benefits generated by a project or policy. In line with this, the Global Facility for Disaster Reduction and Recovery (GFDRR)/World Bank and the United Nations International Strategy for Disaster Reduction (UNISDR) have jointly commissioned an Assessment of the Economics of Disaster Risk Reduction (EDRR) to evaluate economic arguments related to disaster risk reduction through an analytical, conceptual and empirical examination of the themes. Findings of the Assessment are intended to influence broader thinking related to disaster risk and disaster occurrence, awareness of the potential to reduce costs of disasters, and guidance on the implementation of disaster risk-reducing interventions (Subbiah et al. 2008).

One possible approach to this principle is based on the idea to adopt early warning systems (EWS) especially for flood damage reduction. The EWS adoption produces benefits (reduction of damage or loss) which are evaluated using the cost-benefit analysis.

Aspects related to the EWS adoption are mainly linked to Lower and Middle Income Countries. In particular the risk of disaster arises when hazard interacts with vulnerability and low resilience.[19]

As an example, let A be the loss due to a disaster without early warning and B the decreased loss that may be incurred after appropriate measures following early warning, then the potential reduction in damages (or the actual benefit) due to EWS is A minus B. However, let C be the cost or investment required for providing the EWS, then the actual benefit is A-B-C. The benefits due to adoption of the early warning may be estimated by summing the monetary benefits obtained: direct and indirect tangible benefits. The cost of EWS is calculated under three broad components: scientific, institutional and community. In the adoption of the EWS there are several constraints' levels: policy, political, technical institutions, community.

Promotion of innovation

Technological change is a relevant issue in changing the production function of water and hence affecting economic performance of water using sector.

[19] Hazard is a natural event that causes loss of life, injury or other adverse impacts; vulnerability refers to physical, social, economic, environmental and individual factors (poverty, disability, disease, etc.) that increase the likelihood of loss from hazard; resilience is the ability to resist, absorb, accommodate from the effects of a hazard

The performance of different policy instruments in affecting technology through long term changes is discussed in the environmental literature (Requate, 2005), leading to the general conclusion that economic instruments are more effective than regulatory instruments in inducing both adoption and development of advanced abatement technology.

The number of contributions on this issue in the water policy literature is rather poor, particularly concerning economic instruments.

Adoption and development of innovative water saving or efficiency improvement technologies can be seen as an effect, i.e. a component of the evaluation of policy outcomes.

With regard to the issue of innovation, a major distinction can be identified between different policy instruments: a) those instruments directly aimed at providing incentives for technology changes (e.g. subsidy supporting substitution of irrigation machinery), for which innovation is also a policy objective; b) those instruments that are not directly aimed at technology changes, but can have effects in this direction (e.g. volumetric pricing), for which innovation is not necessarily a policy objective.

Technology change occurs over time. The effects of a policy can be seen as: a) an acceleration of the process of technology change (e.g. more efficient irrigation techniques spread more quickly); b) an incentive to move technology change in a specific direction (e.g. water saving).

Water policy can affect changes in technology different from water use technology, hence contributing to determine long term performance (as opposed to short term economic performance) of water using sectors; such effects can be classified as side effects to some extent.

A typical area of research concerns the study of adopting agents in terms of attitudes to technology adoption and speed of adoption. Structural change is an area in which the understanding of non-economic factors in decision making is stronger than short term decisions. For example tacit knowledge and organization’s attitudes show to have a role in infrastructure developments (Wolfe and Hendriks, 2011).

A different perspective is given by pointing to technology change in water management as the main target. Studies advocate the use of economic instruments (e.g. pricing) as a way to increase technology change (Krozer et al., 2010). A range of policy instruments to promote cleaner decentralized water technologies is discussed in Partzsch (2009), concluding that each as strengths and weaknesses compared to the others, and leading to the idea that a combination of instruments could be the best option.

4.3.3 Policy mechanism

Economic analysis can also be used to describe and to assess policy mechanisms. Policy mechanisms can be studied from different perspectives. The relevant concept here is the ability of different policy mechanisms to provide the “right” incentives. This can also be seen as a way to judge to what extent actual mechanisms are able to bring the kind of behavioural change that is expected from an optimal pricing mechanism. This kind of concerns provide a bridge between theoretical policy design and policy implementation.

Prices have three functions:

1. to provide a secure revenue stream sufficient to recover all the monetary costs of the service provided;
2. to allocate scarce resources between competing uses; and
3. to provide a signal and incentive to both producers and consumers as to what behaviours to adopt; in this last role, an increasingly important role is to promote innovation.

In a perfectly competitive market, not only do prices arise in the market, but they simultaneously satisfy all three functions. On the contrary, in the real world, the three functions do not necessarily go together. Thus, a number of writers have proposed that it can be desirable to approach the three functions separately rather than to seek a single approach to dealing with all three functions. This leads to the use of partial parameters such as cost recovery to assess the suitability of actual policy mechanisms.

Cost recovery and revenue generation

Cost recovery can be associated to three main functions informative, incentive and financing (Unnerstall e Messner 2007). The informative function uses the tariff to inform consumers about all costs which depend on their choices about water use. In this way the consumers are motivated to value the resource and to be careful in its use. This leads to the incentive function, that represent the changes in economic behaviour expected as a result of the instrument. This function respond directly to the efficiency principle. Finally, the financing function is based on the idea that consumers payment serve to financially support the costs of services (future investments, environmental protection).

These three main functions work smoothly in theory, while, when we work in the real world, difficulties arise. In the context of water management, cost recovery was introduced by the WFD 60/2000 in a somehow wider perspective: “member states shall take account of the principle of recovery of the costs of water services, including environmental and resource costs, having regard to the economic analysis conducted according to Annex III, and in accordance in particular with the polluter pays principle” (Article 9).

The theory about the cost recovery is quite intuitive, but difficulties arise in the applications because the cost definition depends on the context, and several cost typologies have to be considered (financial, economic, social, environmental, opportunity, direct, indirect), some of which reveal rather difficult to estimate.

In the WFD vision, the full cost components are financial, resource and environmental costs. While the financial costs are “easily” calculated from classical economic accountancy, the evaluation of other two reveals very difficult to estimate.

In Easter and Liu (2005), irrigation cost recovery is divided in three parts: direct project costs, environmental costs, and marginal user costs. “Direct project costs are the easiest of the three to measure, and most projects take only direct costs into account in determining cost recovery. Environmental costs include soil erosion and damage to the surrounding ecosystem during and after the construction of an irrigation project as well as water logging and salinity problems caused by the irrigation. However, few irrigation projects in practice include environmental costs as part of their full cost to be recovered. Environmental costs could substantially raise the total costs of many irrigation projects. Marginal user cost is defined as the present value of future sacrifices implied by current resource use (Howe 1979). It involves the higher costs of obtaining future water supplies because more accessible and less expensive water resources are used up first. In an extreme case, a water resource is completely used up in the current period. This cost is especially relevant for groundwater resources with little or no recharge. Excluding marginal user costs in the price of groundwater often results in overuse of the resource.” (Easter and Liu 2005).

When in a project there is a large indirect benefits, some of the costs may be allocated to the indirect beneficiaries. For example, in countries where the government pursues a low food price policy, food processors and consumers both may benefit more from irrigation improvement projects than farmers. In such cases, subsidizing the project through tax revenue from the benefiting consumers and processors might be an alternative to help fund the project (Easter and Liu 2005).

There are two key steps in cost recovery: the first is to design a pricing mechanism that covers the appropriate costs; the second is to achieve high collection rates through effective water management.

Another aspect to consider when cost recovery is examined is the assessment of the payment ability by the users, i.e. the affordability. This issue has become important since the European countries are facing important investments which, according to cost recovery principle, must be paid by the user. Therefore, many authors have assessed this issue in different countries and conditions (Danesi et al., 2007; Fankhauser and Tepic, 2007; Carvalho et al., 2010).

Incentive compatibility and information assyemtries

Incentive compatibility criteria may relate with the ability of EPIs to provide the “right” economic incentives to agents. This is partly detectable through policy design and economic expectations related to them, e.g. as it occurs for marginal pricing. “Efficient water use policies are about bringing water's opportunity costs in line with its correct marginal value. In principle, if water's price includes all real marginal costs, an efficient resource allocation can be reached: marginal net economic benefits of water are equal across different uses, and society's water-related welfare is maximized. In the absence of well-functioning water markets, opportunity cost assessment requires a systems approach combined with a number of assumptions about impacts and responses to them (Ward and Pulido-Velazquez, 2008)” In Ward and Pulido-Velazquez (2009) a brief review of policy efficiency principles is given:

for Lund and Israel (1995), the efficient water pricing is normally equivalent to pricing at marginal social cost; for Rogers et al. (2002), when the price of water reflects its marginal cost, including environmental externalities and other opportunity costs, the resource will be put to its highest-valued uses; for Briscoe (1996), despite the concept's apparent simplicity, measuring the opportunity cost of water is difficult and in the absence of well-functioning water markets, opportunity cost assessment requires a systems approach and a number of assumptions about real impacts and responses to these impacts.

One possible example of EPIs analysis towards incentive compatibility is given by studies addressing the two-part tariff structure. In some OECD countries (Australia, Austria, Denmark, Finland and the United Kingdom) the two part-tariff is used considering fixed and variable parts. The fixed element protects the supplier from demand fluctuations and reduces financial risks. The variable element charges the consumer according to his consumption level and therefore encourages conservation. One the advantage is the possibility to stabilize the revenue (Roger et al. 2002, OECD 2010).

Incentive compatibility is a particularly relevant issue when water is not metered and straight mechanisms to guarantee incentives to optimal water use cannot be applied (Viaggi et al., 2010).

The issue of asymmetric information is closely related to incentive compatibility, as asymmetric information is one of the main gaps hindering a proper incentive effect by policy instruments. Information asymmetries may lead to overcompensation of agents when subsidies are implemented, or setting of wrong policy parameters (e.g. constraints or fee levels) when other instruments are implemented.

4.4 Possible or suggested indicators

Considering the three main directions of the economic criteria, we can illustrate some questions related to each criterion.

The main objective of the overall aggregation criteria based on the economic efficiency may consider these questions:

- Do EPIs, when compared to the best command-and-control alternative, make a clear contribution to increase the efficiency to which water resources are used by the economy?
- Do EPIs, when compared to their best alternative, allow increasing welfare by reaching at the same time the actual goals of water policy?

The main objective of the economic information as a set of partial criteria may consider these questions (divided by criteria):

Cost effectiveness/cost savings:

- Should EPIs be included in the set of the available measures to reach a given water policy target, would they be part of the least-cost set to reach this policy target?
- When comparing a particular EPI to the policy instruments in place, does this EPI implementation leads to specific cost savings for water users and for the economy as a whole?
- Do EPIs represent a real option to reduce the opportunity cost of achieving the actual goals of water policy?
- Which kind of EPIs has the higher potential to reduce the overall cost of meeting a given target set by a water policy?
- Did the EPI deliver additional benefits as well as cost reductions?

Distributional effects:

- Do EPIs provide a different distribution of income/costs/benefits compared to alternative instruments?
- Who were the winners and losers of the implementation of the EPI? Who incurred costs for the EPI implementation?
- Does the implementation of EPIs, improve the personal situation of someone without worsening that of others?

Risk reduction / Avoided damage:

- What actual contribution can EPIs make toward reducing risk when compared with the best command-and-control alternative?
- Altogether, does the EPI offer a better option to reduce risk and exposure compared to the existing command-and-control option which the EPI is supposed to substitute?

Promotion of innovation

- How does the EPI contributes to structural change and innovation in the water sector and water using agents in the long run?

The main objective of the policy mechanism may consider these questions (divided by criteria):

Cost recovery, revenue generation:

- Do EPIs make it easier (or more difficult) to meet the overall objective of advancing towards the full recovery of the opportunity cost of water services provided to the economy?
- What particular advantages to recovering water services provisioning cost can be derived from implementing a given EPI in a particular water policy context?

- What differences with respect to cost recovery may arise from implementing a particular EPI instead of another one?
- What was the final use of revenues (i.e. tax revenue, auctioning proceeds from tradable allowances) raised through the implementation of the EPI? Were they earmarked?

Incentive compatibility

- To what extent is water policy providing the right incentives (compared to ideally optimal pricing or "true" values of resources)?
- To what extent proper incentives actually apply to agents in cases of asymmetric information (moral hazards, adverse selection)?

The following list of indicators will serve to address questions related to the economic principles discussed above.

Indicator: NPV (net present value)

- Do EPIs, when compared to the best command-and-control alternative, make a clear contribution to increase the efficiency with which water resources are used by the economy? Proxy: Differences between the marginal values of different uses
- Do EPIs, when compared to their best alternative, allow increasing welfare by reaching at the same time the actual goals of water policy? Proxy: Differences of marginal net economic benefits of water across different uses

Indicator: NPC (net present cost), Performance Indicators

- Should EPIs be included in the set of the available measures to reach a given water policy target, would they be part of the least-cost set to reach this policy target? Proxy: Cost per each unit of good used or saved
- Do EPIs represent a real option to reduce the opportunity cost of achieving the actual goals of water policy? Proxy: Water Productivity (WP)
- When comparing a particular EPI to the policy instruments in place, does this EPI implementation lead to specific cost savings for water users and for the economy as a whole? Proxy: Irrigation water productivity (IWP)
- Which kind of EPIs has the higher potential to reduce the overall opportunity cost of meeting a given target of water policy? Proxy: Evapotranspiration water productivity (ETWP)

Indicator: Partial (stakeholder oriented) CBA

- Does the implementation of EPIs improve the personal situation of someone without worsening that of others?

Indicator: Gini indicator

- Do EPIs provide a different distribution of income/costs/benefits compared to alternative instruments?

Indicator: Percentage of recovered costs

- Do EPIs make it easier (or more difficult) to meet the overall objective of advancing towards the full recovery of the opportunity cost of water services provided to the economy?
- What particular advantages to recovering water services provisioning cost can be derived from implementing a given EPI in a particular water policy context?
- What differences with respect to cost recovery may arise from implementing a particular EPI instead of another one?

Indicator: Risk

- What actual contribution can EPIs make to reduce risk when compared with the best command-and-control alternative?
- Does EPI offer a better option to reduce risk and exposure rather than using the existing command-and-control option in its stead?

4.5 Demonstration Example

Irrigation schemes in Italy (Emilia Romagna) are good examples of the articulation and complementarity of these criteria. Project decisions are mainly based using CBA technique (if any formal technique is used). Cost-effectiveness methods are being proposed for complementary infrastructure or water saving components of irrigation infrastructures. In the allocation of water use opportunities, a mix of equity (same water availability to all farmers, or per hectare) and incentive mechanisms (e.g. some fixed payment to gain the right to access water pipes) are used. Water pricing is mainly set in order to achieve costs (O&M) recovery, so it is not necessarily compatible with marginal pricing or other incentive mechanisms. However a debate is open about shifting to volumetric pricing, with related infrastructural and metering costs. The possibility to shift to some form of water market is precluded by the lack of any legal basis at the moment in Italy. In addition, the idea of rights transfer among farmers seems often to conflict with the pricing strategies by the irrigation boards (e.g. block tariffs if available).

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5. Enhanced Measurement of Distributional Effects

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5.1 Introduction

At its most basic, social equity concerns questions over 'fairness' in the allocation of goods and services across different members of society. There are many different models of social equity which describe varying interpretations of 'fair' resource allocation and 'just' distributions of wealth and capital (Elster, 1992; Sagoff, 1988). Traditional approaches to assessing distributional differences in light of distributional justice tend to take the approach of using material wealth as a basis for defining those 'deprived' and those 'not deprived' against which other comparisons can be made (Canberra Group, 2001; Nolan et al 2009).

Traditional approaches to assessing wealth, usually at a national scale through measures such as GDP, have been criticised for disguising inequities at the local scale (e.g. Abraham 2005 and Boarini et al 2006). Alternatives to traditional measures have led to questions over not only how to better account for those local scale variations, but also questions regarding what is important to measure. The ideas of capturing aspects besides simply material wealth in order to assess "how society is doing" (Beaumont, 2011) have resulted in the development of alternative measures designed to improve on GDP and GNP measures (Boarini et al 2006; Layard, 1980). These alternatives include the Human Development Index and Index of Sustainable Economic Welfare (which combines GDP with distributions) to subjective well-being which considers life satisfaction through interviewing individuals (Vemuri et al). In addition to others (Abraham 2005; Canberra Group, 2001) the Stiglitz et al (2009) report supports the move away from a single measure "there are many inequalities and each is significant in itself: this suggests that we should avoid the presumption that one of them (e.g. income) will always encompass the others".

As early as the 19th century notable thinkers such as Jeremy Bentham explored concepts of 'happiness' and 'well-being' in policy decision making. He also considered the scale at which measurement could be applied. In fact his development of the greatest happiness principle was to be applied at the individual, community, state, or whole human race scales (Collard 2006). Whilst concepts such as 'happiness' can be viewed as an improvement on GDP and attempts made to measure them (Layard 1980, 2010) their conceptual limitations and the limitations of measurement remain debated. For example whilst Brittan (2001) is critical of the measurement of happiness using a social survey approach he acknowledges that without an alternative, such as direct observation of behaviour, it is currently the best approach.

The debate on how to measure and actual attempts at measurement reveal the challenges of representing such subjective interpretations (Boarini et al 2006).

Measurement in terms of ranges of response or scales are also implied in Bentham's observations. Recently there have been developments of different types of measurement scales which can result in a single indication numeric. These include the human development index (Oswald and Wu 2010, Vemuri et al. 2006, Sagar et al. 1998) and the gender equality index (Plantenga et al. 2009). In terms of an application of an approach at a national scale there has been the first measurement of well-being in the UK, the report pending (Beaumont, 2011). But in comparison to these approaches Stiglitz et al (2009) keeps the assessment as a profile of measures rather than attempting to generate a single index. Early direction by Bentham still holds true today in measurement approaches including the Stiglitz et al. guidance. The measurement should always apply to those 'whose interest is in question' or in today's terminology, the stakeholders and that the list of factors affecting well-being should be all those things (and only those things) to which the respondents attach importance (Collard 2006).

These insights are taken forward in this project. The project considers the implications of different economic policy instruments (EPI) for different stakeholder groups. In order to do this it is important to understanding why an EPI may not be acceptable or successful. This can be achieved by covering a range of implications and effects on an EPI to ensure that anything implicated in the failure of an EPI is determined. This will inform an understanding of the conditions that may lead to problems in implementing the EPI and highlight opportunities to address these problems to improve the potential for successful implementation.

5.2 Typology

As highlighted, there are a number of different approaches to measuring policy impacts. This project will enhance traditional approaches to exploring EPI performance by utilising the recent developments in approach already outlined. Whilst the goal of this project is not to measure well-being and happiness the variables and methods employed will attempt to capture a full range of EPI impacts. The project will focus on using the categorisation developed by the Stiglitz Commission as a good example of a comprehensive (but not exhaustive) categorisation. The Stiglitz Commission identifies a set of eight impact areas which are set out below[20]:

- Material living standards

[20] For the purposes of this project, these 8 categories have been slightly adjusted. 'Personal activities including work' has been divided into separate categories for personal activities (i.e. leisure time, non-work time) and employment. The division was to emphasise employment as a category in itself to capture that particular element of an EPI and personal activities mainly focuses on time budgets, leisure time and factors relating to leisure activity. Furthermore, the final category, 'Insecurity' has been adjusted to 'Security' to enable a measurement using the same scale where the attribute is seen as positive.

- Health
- Education
- Personal activities including work
- Political voice and governance
- Social connections and relationships
- Environment (present and future conditions)
- Insecurity, of an economic as well as physical nature

5.3 Assessment methods and technique

The aim of the methodology is to capture the wider impacts of an EPI. These wider impacts, whilst often neglected could have a significant influence on the acceptability and thus the success of an EPI in implementation. To capture the actual, perceived or anticipated effects of the EPI on the impact categories above, the following methodology has been devised as a simple and efficient way to reveal the full range of impacts.

Ideally, to understand the impacts of the EPI from different stakeholder perspectives it would be best to assess the initial conditions prior to the EPI's application. These conditions should then be compared with the resulting state after the application of the EPI to assess the impact or contribution of the EPI (See Figure B-2 below).

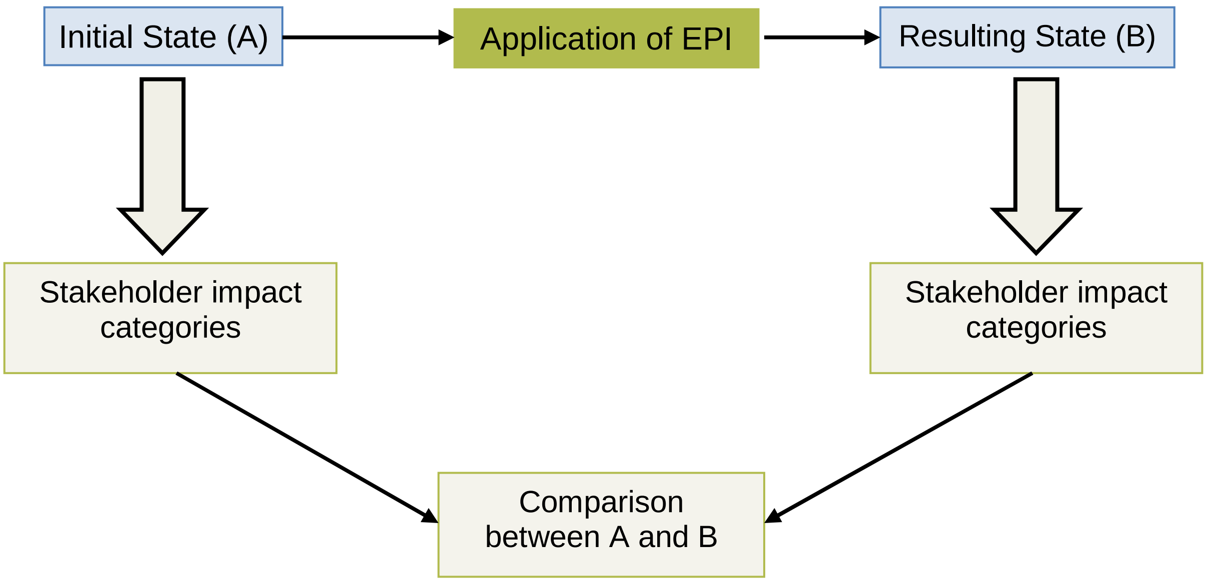

Figure B-2. Assessment Framework for Task 2.3

However, the reality is that many EPI's are implemented over many years and may have started before this project. As such it is not always possible to take the above described approach. Indeed, this project will assesses EPI's initially as an ex-post exercise (Work Package 3) and then as an ex-ante exercise (Work Package 4).

For the ex-post case studies, the approach is to take the present status of the EPI (during or following application of an EPI) and to look back to the initial conditions to understand the changes that have occurred following its introduction. For the ex-ante case studies, a different approach is required which involves making judgements on how an EPI might be expected to change the impact areas, based on pre-determined scenarios.

To capture all of the relevant information for each case study, the methodology comprises two essential components:

1) Analysis of secondary data (i.e. case study reports and surveys)
2) Interviews with stakeholders to verify secondary data and reveal missing information and important dynamics.

It is the interpretation of these **two sources** of information **together** that should be presented in the results.

Where possible, secondary data should be accessed and analysed to identify and begin to understand the effects and influence of an EPI on the impact areas already listed. This data may be qualitative or quantitative data which can be used to establish a general trend of influence that results from the EPI on some or all of the indicators listed. The next step is to conduct interviews.

As the Stiglitz report emphasises, the impact categories should not be assessed merely in terms of money or quantitative measures. A detailed approach to measurement will follow but first it is important to identify the respondents of the interviews.

Different stakeholder groups will be affected to varying degrees and in different ways to the impact of an EPI. As such, the impacts will be considered for different stakeholder groups. Table B-3, below, attempts to broadly define the main stakeholder groups that could be identified in each case study. However, the final identification of relevant stakeholder groups will depend on case study specifically.

Table B-3. Descriptions of possible Stakeholder Groups

Stakeholder Group	Description
Farmers	Those whose employment primarily involves the farming of crops and/or livestock located within the area directly affected by the EPI
Local community/ residents	Those living in the area directly affected by the EPI.

Stakeholder Group	Description
Wider community	Those living outside of the area directly affected by the EPI but who may experience indirect effects of the EPI.
Businesses	May be subdivided into categories of large, medium and small businesses. These are any business directly affected by the EPI.
Water companies/ organisations	Businesses, organisations and services involved in the provision of water and sanitation services, in the area affected by the EPI.
Future generations	Viewed as local community/residents of the future.

To identify the stakeholders relevant to a specific case study a stakeholder analysis can be conducted. A stakeholder analysis is simply a systematic approach to help ensure that all stakeholder groups involved are identified and their relevance to the issues understood. There are different approaches to the analysis some involve mapping relationships and stakeholder's understanding of the issue (Raadgever et al, 2008; Billgren and Holmén 2008; Klinke 2009) or another categorisation based on a wide variety of characteristics in relation to the issue. Some examples of categories that may be useful to consider are as follows[21]:

- **Sector** (public, private, voluntary, community)
- **Function** (user, service provider, regulator, landowners, decision-maker)
- **Geography** (living within or outside the impact area)
- **Socio-economic** (income, gender, age, length of time living in area)
- **Effect** (directly affected, indirectly affected, able to affect the issue)
- **Understanding/experience** of the issue (none, low , medium, high, more than you)
- **Known or likely position** (for or against the EPI)

[21] Environment Agency, Building Trust with Others; A guide for staff, p.13

The analyst attempts to list all the stakeholder groups they can think of relevant to the EPI measure for each category in turn. Ideally a number of different analysts undertake this task to allow different insights to reveal all the stakeholders. At the end of this process all the category lists are combined to hopefully produce an exhaustive list of stakeholder groups. An understanding of each stakeholder group's knowledge, connections, influence and interest in relation to the EPI will help the analyst determine which groups will usefully be interviewed to establish a complete picture of the EPI impacts. Representatives of the different stakeholder groups will then need to be identified and invited to participate.

It is important to note that even within a stakeholder group it might be necessary to interview different individuals to obtain perspectives at say a strategic and at an operational level. Ideally each perspective should be repeated with additional individuals until repetition of issues occurs during the interviews thus ensuring the data is representative. However, when dealing with organisations often this might not be possible because repetition of responsibilities amongst staff within organisations is usually avoided. But for other stakeholders such as consumers or farmers additional interviews may be undertaken.

Once the relevant stakeholders have been identified and recruited then interviews can be undertaken. A qualitative approach has been adopted because of the limitations of the sample in terms of statistical analysis (i.e. there may only be 5 people that work on the EPI at a water company and therefore interviewing these 5 people results in too small a sample for statistical analysis but is fully representative of the views of that stakeholder group). More importantly the flexibility of the qualitative interview technique is essential to elicit answers to the EPI impacts and gain an understanding of the interactions that are taking place which are often varied and sometimes subtle. Interviews are an appropriate method for the completion of the results to substantiate and develop the information from secondary sources (Stiglitz et al. 2009).

Ideally interviews should be undertaken face to face with a single respondent. This arrangement facilitates a better environment for the interviewer to explain, direct, discuss and reveal information. It also enables the respondent to show additional materials to explain their perspectives. If a face to face interview is not possible, a telephone interview is an acceptable alternative and may be most effective by emailing the matrix to the respondent before calling them so that they can refer to it during the interview call. In both cases the interview might, with their permission, be audio taped to allow the interviewer to focus on the questioning rather than taking notes. In the **Ex-Post research** the interview can start with a general introduction from the interviewer regarding the project research followed by general questioning regarding the respondents responsibilities, involvement in the EPI and the organisations motivations for involvement. Once the respondent is settled into the interview the Matrix can be introduced.

5.4 Indicators

To facilitate the interviews and ensure that they are consistent in approach, but also simple and efficient, the following grid can be used as a basis for discussion. First show the whole grid to the respondent so that they can see each category. The impact categories are worded so as to enable stakeholders to define the impact categories in their own terms and on discussing each category this should be encouraged.

Depending on the ability and engagement of the respondent working through each impact category on the grid in turn, the respondent can be asked to explain what each one means to them and where they would score the EPI's influence on the neutral, positive and negative scale in relation to their organisation, business or household. Schiellerup and Chiavari (2009) have used this simple method on a similar project to enable the analysis of such mixed data. Their approach is simply to consider the change from the initial state or base scenario to post implementation as either a positive, negative or neutral change. This will demonstrate the nature of a change and to emphasise the degree of change, two pluses or two minuses may be used if there is a large, notable change.

+ represents a positive change from base scenario to implementation of EPI

0 represents no discernible change from base scenario to implementation of EPI

- represents a negative change from base scenario to implementation of EPI

Criteria	Direction of change / Importance				
	--	-	0	+	++
Material Living Standards					
Health					
Education					
Personal Activities					
Employment					
Environment					
Security					
Political Voice					
Social connections and relationships					

Table B-4. Blank grid for use in interviews and analysis

It is important at each impact category the interviewer fully explores the reasons for the respondents' rating and this might include the interactions with other impact categories or even other EPI measures that might be operating. At the end the respondent should be asked if there are any additional impact categories that should be included and not listed.

Once the grid has been filled the interviewer needs to ask the respondent for each impact category in turn how important it was for them in facilitating, using or benefiting from the EPI.

+ represents high importance

0 represents neither important nor unimportant

- represents a low importance

There is now an opportunity to ask again for the respondents views of how another stakeholder group was affected. For example you might be interviewing the representative of a water company but then after they rated their own position to then rate it from a farmers perspective. The number of additional stakeholders asked will depend on the time available in the interview.

Once this has been achieved any additional questions can be pursued by the interviewer to further clarify the data and then a very short summary of the whole interview should be given by the interviewer to the respondent to confirm that the interviewer has understood the respondent correctly. Finally the respondent should be given the opportunity to ask or say any additional information they feel was important but not covered in the interview.

For the **Ex-Ante research** a similar approach is undertaken but this time in careful introduction of the research the respondent is also asked what role they might have in an EPI already described by the interviewer. This description will lead to possibly a maximum of three different scenario's of either funding or economic or legislative environments in which the EPI will operate or differences in the EPI that might affect the stakeholder. For each scenario the stakeholder will be asked to rate the possible impacts and importance with again the prompting for explanation from the interviewer.

5.5 Social Equity Assessment

For both the Ex-Post and Ex-Ante research the analyst will have a number of grids of different stakeholder perspectives of the EPI or the scenarios. A systematic analysis would be for the Ex-Post research to take each impact category comment on the similarities and differences from the different stakeholder perspectives. Combining these with the importance ratings, the grids can be analysed to understand how criteria are perceived to be impacted by stakeholders and whether this may conflict with the importance values attached to the criteria. For example, if stakeholders perceive health to be particularly negatively affected by an EPI but feel that health is a highly important aspect, this can be seen as a potential threat to the success of the EPI.

Cross referring between the two grids can build a picture of the nature of the impact of the EPI and the degree to which these impacts are likely to be acceptable for each stakeholder group. From this point a distributional impact analysis can be conducted to assess which (if any) stakeholders are most negatively and positively impacted, highlighting potential distributional justice issues. This in turn will reveal opportunities for implementation of an EPI perhaps informing the structure of the EPI and communication strategy to stakeholders.

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5.7 Additional material

Small/independent businesses, large businesses and water companies

Welbeing component	Key question	Type of method	Tool	Comments
Material Living Standards	Have profits changes? Has income and expenditure changed?	Quantitative	Income data- national, regional or local statistics. Possibly even individual farm accounts?	
Health	Have workers' stress levels altered?	Qualitative	Surveys or interviews with a sample of employers and/or employees	Qualitative surveys, may be based on national health surveys.
Education	Is a level of education required for effective implementation?			
Does the EPI process provide education in itself?	Qualitative	Surveys or interviews with a sample of employers and/or employees		
Observation				
Personal Activities	Have time budgets changed- has the amount of leisure time increased or decreased?	Qualitative	Surveys or interviews with a sample of employees and/or employers	Specifically assessing perceived changes in the time budget- i.e. do they have more or less leisure time as a result of the EPI?

Employment	Has employment in the sector increased, decreased or stayed the same? Has employment within the business increased, decreased or stayed the same? Have employment opportunities within the sector changed	Quantitative - Qualitative		Qualitative for employment opportunities question

Welbeing component	Key question	Type of method	Tool	Comments
Environment	Have employees and businesses noticed a change in the appearance and quality of their environment?	Qualitative	Surveys or interviews with a sample of employers and/or employees	
Insecurity	Do business managers feel their business is more or less secure as a result of the EPI?	Qualitative	Surveys or interviews with a sample of employers and/or employees	
Political Voice	Do business managers feel they have a greater or weaker say?	Qualitative	Surveys or interviews with a sample of employers and/or employees	
Social connections and relationships	How have social connections and relationships changed	Qualitative	Surveys or interviews with a sample of employers and/or employees	

Local community/residents and Wider Consumers

Welbeing component	Key question	Type of method	Tool	Comments
Material Living Standards	Has household expenditure and income increased or	Quantitative	National, regional, local statistics	Data may be routinely collected at the national and/or local level that could be of use here.

Welbeing component	Key question	Type of method	Tool	Comments
	decrease?	Qualitative	Surveys or interviews with a sample of local residents	To supplement the quantitative data where necessary
Health	Has the EPI resulted in an improvement or decline in drinking water quality?	Quantitative	Water quality tests	This may be conducted as part of another task, in which case beware of double counting. Possibly ask about colour and odour changes instead.
Education	Does the EPI involve a process of education or does it require a degree of education to be effective?	Qualitative	Observation	Identification as part of the implementation process. Project leaders can assess this.
Personal Activities	Does the EPI result in an increase or reduction of time for leisure purposes?	Qualitative	Surveys or interviews with a sample of local residents	Specifically assessing perceived changes in the time budget- i.e. do they have more or less leisure time as a result of the EPI?
Employment	Does the EPI provide employment prospects or losses of employment?	Quantitative	National, regional, local statistics	Data may be routinely collected at the national and/or local level that could be of use here.
		Qualitative	Surveys or interviews with a sample of local residents	Specifically assessing perceived changes in employment- i.e. do they think employment as increased or decreased?
Environment	Has the appearance of the local environment improved or declined?	Qualitative	Surveys or interviews with a sample of local residents	Specifically assessing perceived changes in the environment- i.e. do they think the environment is better or worse off than before?
Insecurity	Has the EPI increased or decreased faith in local water quality?	Qualitative	Surveys or interviews with a sample of local residents	Assessing how people feel towards water quality as a result of the EPI.

Welbeing component	Key question	Type of method	Tool	Comments
Political Voice	Has the EPI given a stronger or weaker political voice to any particular groups?	Qualitative	Surveys or interviews with a large sample of local residents	Cover a range of local groups to assess where power may have shifted and where gains and losses have accumulated
Social connections and relationships	Have social connections altered following the introduction of the EPI?	Qualitative	Surveys or interviews with a sample of local residents	Cover a range of local groups to assess where social connections and relationships may have shifted

Future Generations

Welbeing component	Key question	Type of method	Tool	Comments
Material Living Standards	Will income and expenditure increase or decrease?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	
Health	Will drinking water quality be improved?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	
Education	Will there be a requirement for an ongoing process of education?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	
Personal Activities	Will time budgets and leisure time be affected?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	
Employment	Are employment opportunities likely to be affected? Will they be greater or	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews	

Welbeing component	Key question	Type of method	Tool	Comments
	worse as a result?		with local community.	
Environment	Is the appearance of the environment likely to be improved or worsened?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	
Insecurity	Can any insecurity issues be foreseen?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	This feature will be particularly challenging to assess and full assessment may be unrealistic
Political Voice	Can any impact on political voice be foreseen?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	This feature will be particularly challenging to assess and full assessment may be unrealistic
Social connections and relationships	Can any social connection changes be foreseen?	Qualitative	An assessment of the trend following the introduction of the EPI and indications from surveys and interviews with local community.	This feature will be particularly challenging to assess and full assessment may be unrealistic

6. Institutions

David Zetland and Hans-Peter Weikard (WU)*

6.1 Introduction

Institutions are the formal rules and informal norms that define and modify the choice sets of individuals and their interactions by affecting the cost of exchange (transaction costs) and production (transformation costs) (Saleth and Dinar 2004, p. 25; North 1990, pp. 5-6). Usually, the level of an institution or its depth and persistency (see further below) determines whether it imposes a hard or a soft constraint on decision makers' choices. Most institutions are difficult to describe, highly adapted to local conditions, and effective in balancing many competing interests. Robust institutions have a greater impact (limiting or directing action); fair institutions apply limits to everyone; efficient institutions increase social welfare. Weak institutions allow elites to exploit the majority, wasting resources to extract benefits for themselves.

Neo-classical models of interaction tend to ignore institutions, which means that deviations from predicted outcomes can perhaps be partly attributed to missing or misspecified institutions (Hodgson 1998, 2006 and Williamson 2000). Production decisions, for example, may consider opportunity costs that are visible to producers but not analysts. Institutional constraints derived from "culture," work methods or other rules can keep production inside the efficiency frontier that omits institutional effects.

Institutions can form an insurmountable barrier to the importation of foreign ideas, such as EPIs, but the uncritical imposition of institutional modes in differing contexts may be "dysfunctional and even counter-productive" (Shah et al 2005, p. 46), as the development of water management institutions is highly contextual, path-dependent and incremental (North, 1990; Bandaragoda, 2006). Outdated institutions cause trouble. Saleth and Dinar (2004) explain how the combination of outdated institutions and water scarcity can lead to more scarcity, because policies meant to alleviate the problem instead worsen it [pp. 8–13]. The implementation of a water market in an area without restrictions on groundwater use, for example, may lead to increased groundwater pumping to replace surface waters that are sold to out-of-area buyers.

Institutions and transaction costs (TCs, see Section 7) both affect "frictionless trade." They can be related and separated by visualizing a continuous line that extends from one extreme (action is prohibited by an institutional barrier) through a middle (institutions have impacts and transaction costs have strong effects) to the opposite

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extreme of zero TCs (pre-Coasian neoclassical markets). We will separate them in our analysis by associating institutions with exogenous impacts on EPIs and TCs with the fixed costs of implementing an EPI and variable costs of operating it. A water market, for example, is established with fixed TCs and operated with variable TCs, but both are affected (positively and negatively) by institutions.

EPIs create/modify institutions (e.g., new markets or tax adjustments, respectively) or influence institutions (water law, policy or administration) that affect existing markets and bureaucracies, choices and behavior. The case for adopting EPIs grows stronger with water scarcity (Saleth and Dinar 2004).

Institutions can be viewed as a constellation of hierarchically nested rules which Williamson (2000) analyses on four interconnected levels (see Figure 4 in Part I). The top level (L1) refers to "culture" and other informal norms that evolve over centuries. L2 refers to basic rules (such as constitutions) that rest for decades or centuries. These rules change very slowly. L3 is most relevant to EPI because it refers to the institutions that guide interactions in L4. EPIs are implemented at this level, but they must consider - and will be affected by – L1 and L2 institutions. L1 institutions often create path dependency; L2 and L3 institutions can be designed; emergent behaviour is seen in L4 institutions (transactions). These behaviours can lead to changes in L2/3 institutions or be integrated into L1 institutions.

Williamson describes how institutional characteristics create constraints that limit feasible options to a "2nd best" action, for example. Application of such institutional analysis when comparing an existing (or proposed) EPI to a counterfactual (or existing) situation is necessary for objectivity and relevance.

Institutional analysis often focuses on the unique factors or interactions that affect outcomes. Such lack of generality means that most mathematical and numeric models of institutions are useless in the same way that a 1:1 scale map is useless. The tacit nature of institutional details makes them hard for outsiders to see, understand or weigh, even as insiders have a "feel" for how institutions affect the process that turns inputs into outputs.

Pommerehne and Feld (1994), for example, explore how a German community was able to overcome free-rider problems to build an incinerator in France. Under traditional economic theory, local citizens would have been unable to find a voluntary method to coordinate their actions, and they had no legal framework for force cooperation. Local norms made it possible for them to cooperate to contribute to the public good.

Our objective in EPI-WATER is to identify and describe institutions that affect the design, implementation and operation of EPIs. Our descriptions are unlikely to be quantitative in the same way that it's difficult to quantify "cooperation" or "market-friendliness" in a community. It may be possible to import national indicators (e.g., Transparency International's Corruption Perceptions Index), but these large-scale indicators do not often describe local conditions or individuals working with EPIs.

We will merely identify relevant institutions and how they support or undermine EPIs.

6.2 Typology

Institutions are relevant for all case studies in EPI-WATER. They influence the ex-ante status quo; options for action and implementation of EPIs; TCs (information, negotiation, implementation and enforcement); and the probability of success. Institutional characteristics include culture, path-dependency, tacit knowledge, multi-dimensional objective functions, aggregated objective functions, and so on. Some institutions need to be created anew in each location (e.g., via social learning), others are persistent (e.g., path-dependency) or recurring (the EU regulations affecting interactions with non-EU members). Institutions may conflict (e.g., formal rules of the WFD that conflict with informal norms), but they rarely change as fast as expected. Institutions evolve in response to physical and human forces, recent developments, and future expectations of changes in costs and benefits.

Institutions can intentionally or unintentionally improve productivity: The European norm of dense housing that originated in a past of scarce building materials, slow transportation and defence against attackers, for example, facilitates modern public transportation, wireless infrastructure and cooperative tendencies. They can also raise costs and lower productivity: monopolistic water utilities established long ago may not have the scale to treating water to current standards, but they cannot be forced to merge.

Look for a mismatch between institutions and conditions (costly institutions) or flexibility in dealing with outside shocks (beneficial institutions). Institutions for managing water (in any sector) are usually better at dealing with risk if they are designed for specific tasks and scales (e.g., flood control within a watershed), mainly because such specialization makes it easier to match costs and benefits.

Those general statements are vague, so it may help to use a more concrete definition from Saleth and Dinar (2004), who characterize [p. 97] water institutions in a way that's very similar to Williamson (2000), i.e., as a combination of water law (L2), water policy (L3) and water administration (L4).[22] They go on (chapters 6–10) to try to identify significant variables associated with each of these broad categories, but their technique makes it hard to draw strong conclusions:[23] They find that overall performance of the water sector depends on four legal indicators (effective conflict resolution provisions, legal integration, centralization within law, water-rights

[22] They divide institutions into formal "arrangements" (organizations or governance structures) and informal "environments" (institutions), but these categories often overlap.

[23] They combine survey answers from over 100 water policy professionals into two- or three-stage sets of structural equations meant to reproduce dependent/independent relationships connected to water sector performance. The system is too complicated for ceteris paribus analogy, analysis and conclusion.

format), two policy indicators (cost-recovery status and effectiveness of user participation policy), and five administrative indicators (seriousness of the budget constraint, technology application, balanced functional specification, information adequacy, existence of an independent water-pricing body); the weights attributed to each of these indicators by respondents varies with their discipline (e.g., social scientist vs. engineer) and their local water conditions [p. 311].

6.3 Assessment methods and technique

EPI assessment should consider benefits that are direct (e.g., improvements in water quality) and indirect (e.g., changes in health conditions) as well as costs (e.g., subsidies for environmentally friendly behaviour) must also be counted. Institutions affect these costs and benefits by changing incentives that change behavior that lead to direct and indirect outcomes.

Institutions are difficult to test in simulated or toolbox conditions. In some ways, they are totally inappropriate for dissection and analysis via any sort of "tool" that pretends to simplify and normalize. Coase (1998), for example, says:

> *Mainstream economics...is in fact little concerned with what happens in the real world... economists think of themselves as having a box of tools but no subject matter... I have expressed the same thought by saying that we study the circulation of the blood without a body... I think we should use these analytical tools to study the economic system... That such work is needed is made clear by another feature of economics. Apart from the formalization of the theory, the way we look at the working of the economic system has been extraordinarily static over the years... The costs of coordination within a firm and the level of transaction costs that it faces are affected by its ability to purchase inputs from other firms, and their ability to supply these inputs depends in part on their costs of coordination and the level of transaction costs that they face which are similarly affected by what these are in still other firms. What we are dealing with is a complex interrelated structure. Add to this the influence of the laws, of the social system, and of the culture, as well as the effects of technological changes... and you have a complicated set of interrelationships the nature of which will take much dedicated work over a long period to discover.*

Coase's warning implies that our best shot at assessment lies with a simulated comparison of a past real shock, response and impact to a future or proposed shock. It may be impossible to benchmark or assess unique institutions in different places. An institution for managing water that produces a 10 percent increase in yield in one irrigation district may reduce yield by 5 percent in another location, probably because it's not so easy to "copy and paste" an institution. On the other hand, this result may make it easier to compare and identify the factors that differ from one place to the next and perhaps highlight institutional elements contributing to efficiency, portability, and/or failures of EPIs.

It's possible to compare the outcome under an existing set of institutions against a "friction-free, perfect efficiency" benchmark derived from a mathematical or simulated model, but this technique can be wrong in two ways. First, because it may be impossible to actually implement the framework in the model (i.e., the institutional status quo is already second-best). Second, the replacement of an institution that serves multiple functions may result in perfect efficiency in the target area but total disaster in the ignored area. A storm water system may be very good at draining water from streets, but the resulting concentration in flows may reduce groundwater recharge and overwhelm the wastewater treatment plant.

6.4 Possible or suggested indicators

Institutional analysis should consider exogenous factors affecting the origin, design, implementation, and operation of the EPI The delivery mechanism (DM) often integrates helpful and harmful forces originating in institutions. These exogenous factors can explain why the DM for an EPI varies from location to location. We suggest that case study authors reflect on how each institutional level (from deep L1 to shallow L4) affected the design, implementation and performance of an EPI.

In theory, we need to identify all related impacts from an EPI, the changes it imposes on "unrelated" status quo institutions, and the administrative parties that may have nothing to do with costs and benefits from the EPI but who are necessary to implement the EPI. It also makes sense to survey local familiarity with the EPI; ideas that are too strange cannot fit within local culture. Note that "strange" is quite subjective. Farmers who pay for fuel, seed and rented land may not understand that they should pay for water extraction. Is that because they don't want to pay for anything (L4) or because the whole idea is just too foreign (L1)?

A sequential description of institutional effects fits a narrative framework, i.e.,

1. Describe institutions affecting the creation of the EPI
2. Tell how EPI operations were affected by institutions.
3. Tell how EPI changed existing institutions or established new institutions
4. If the EPI fails, then what was the cause? Blocking majority? Failure to consider institutional details?

6.5 Demonstration example

WUR is examining groundwater taxes (national) and fees (provincial) in the Netherlands. Both are based on certain types of groundwater extraction (e.g., drinking water, livestock, tulips and pasture are treated differently). They are affected/complemented by regulations on water use and how taxes are levied (small pumps are exempt, for example). The institutional dimensions of the taxes and fees vary at the provincial level in a way that can be compared (water use for pasture is allowed in some provinces but not others) and cannot be compared (the fees cover the cost of staff and equipment devoted to "sustainable" groundwater use). National

Institutions

taxes are not meant to affect behavior at all; they are green taxes meant to reduce other taxes (e.g., income tax), not to change behavior.

So we may say that the national tax is mostly ineffective in changing groundwater consumption, except that was the advertised goal. The institutional indicator may be "what's the targeted goal/weakness?" (fiscal vs. behavioral instead of both, which is often the promise of win-win EPIs). The provincial user fees are targeted at the indicator of "user pays," i.e., what's the distribution of costs and benefits from the EPI? Contrast this to the *within* user distribution of costs and benefits from the fee (of the tax) that takes place in the agricultural community. Some farmers, lands and activities are exempt – either because of historic favouritism, lobbying, strategic interest, political favouritism, hydrological facts, or monitoring costs.

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7. Policy Implementability

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7.1 Introduction

Even theoretically sound and efficient policy instruments may fail to produce expected results, or worse, set off unintended consequences which further exacerbated the problems faced. In this task, policy implementability is understood as the analysis of all factors (sub-criteria and indicators) which determine whether the EPI as such can be implemented in practice, or would fail if implemented.

Policy implementability is not about how to design an (optimal) EPI in theory, nor about whether a particular EPI is worse or better-suited than a hypothetical alternative regulation; these aspects are addressed in the remaining tasks of the analysis. This task is about judging whether a given EPI:

- Is likely to be implemented in the first place: Can the EPI gain enough political traction and support from policy makers and the public?
- Is likely to perform as expected, once it has been implemented: Can it be sufficiently adjusted to perform well in local circumstances and to changing conditions over time? Are the differing institutions, e.g. Ministries, cooperative in its implementation and operation? Are there barriers to implementation, such as existing (EU) policies?

The task identifies and defines key factors that are important for implementation of EPIs at the policy level and recommends of methods for their measurement and elicitation for their evaluation. Failure may be traced to faults in design, the implementation process or external factors.

Additionally, the failure in implementation may be related to institutions (endogenous) and transaction costs (exogenous) – these factors are considered in the respective tasks.

The policy analysis described in this section will be different for the ex-post and ex-ante assessments that are undertaken within the EPI-WATER project in WP3 and WP4 respectively. The ex-post assessment exercise will collect experiences and

lessons learned from earlier attempts to put EPIs in place in different, favourable or unfavourable contexts. The ex-ante exercises on the other hand will incorporate the lessons learned into the design of the proposed policy instruments in order to increase the prospect of their successful implementation. The focal areas introduced in this section, however, are the same for both assessments.

7.2 Typology

The policy cycle

For the purpose of this document, a *policy* is defined as a principle or rule to guide decisions and achieve rational outcome(s). Policies and policy goals are put in practice via policy instruments that may be regulatory (e.g. legislations and regulations), economic (e.g. taxes, subsidies), or others.

Figure.1 shows a simplified version of a policy cycle which illustrates how a policy is developed, implemented and reviewed.

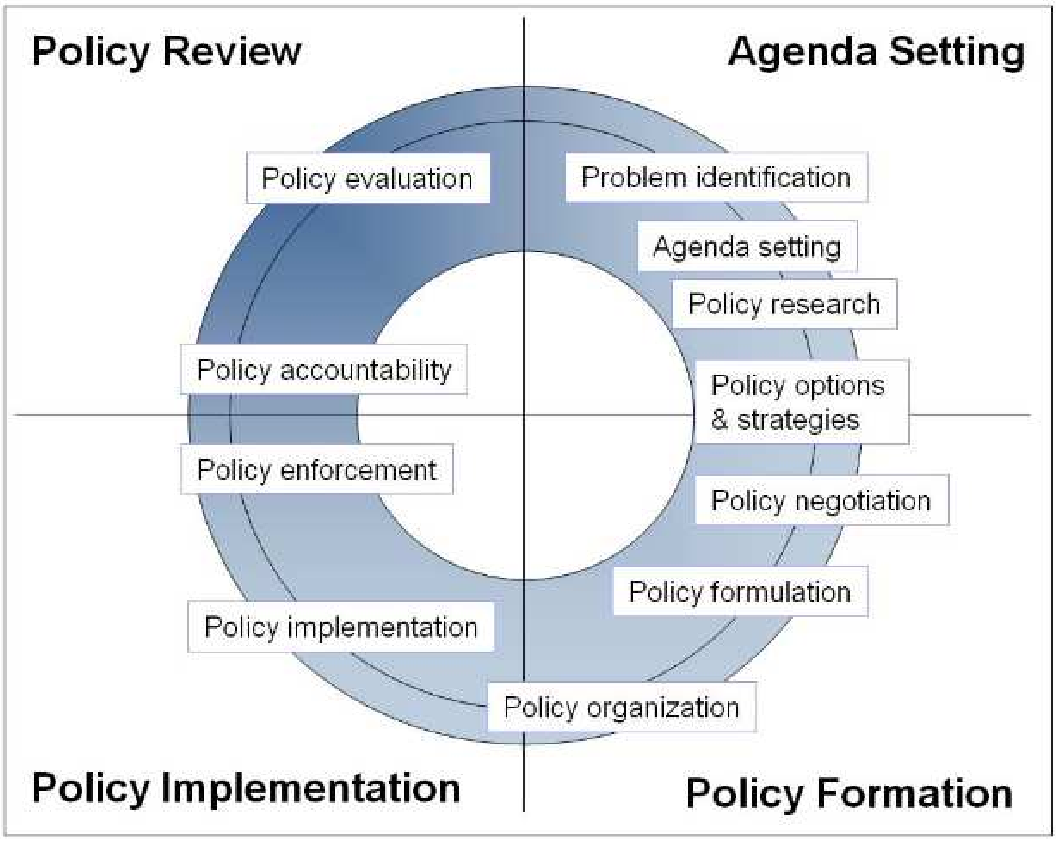

Figure.1 Policy Cycle.

Source: Ecoinformatics International Inc.

The development, implementation and review of policies is an iterative process. It starts with the problem definition, the search for possible solutions and the agenda setting. During the *agenda setting* process the problem in question as well as potential solutions are made public and involve public participation to raise the profile of the problem and the solutions (= policies, policy instruments). In the next step, the *policy is formulated,* i.e. following the discussion of proposed options, policy makers adopt new or amend existing policies. This can be extended to the public, by for example holding a referendum on which policy to adopt. Then, the *policy is implemented and enforced*, i.e. the government executes an adopted policy. Following this step, the policy will have certain outcomes which can be traced back to behavioural change.

The final phase involves the *policy review*. In this phase the policies are evaluated on their performance and whether it meets its expected and desired outcomes in practice. The policy cycle is an iterative process – once the policy review is completed, the policy cycle begins anew with the problem definition and agenda setting.

The Policy Implementation Phase

The *policy implementation phase* is critical as the theoretical ideas of the policy (instrument) need to be adapted to match practical realities. It is not a clear-cut and automatic process which occurs following the adoption of the precedent legislation but may be limited by a number of factors which affect the ability of the political system to put policies into effect to achieve the desired outcomes (PSU, 2008). Peters (2007:104 in PSU, 2008) states that "it is much easier to prevent a policy from working than it is to make it effective" – a comment which demands attention. Theodoulou and Kofinis (2004) find that the success of a policy depends on how well it has been implemented in the first place.

As the development of river basins and their institutions is highly contextual (Bandaragoda, 2006), the ability of adjusting EPIs to these contextual circumstances is of utmost importance (Shah et al, 2005). The attempt to replicate the "user pays policy" from Australia to the Solomon Islands, for example, showed that the 'direct transposition of "user pays policy" was not sustainably viable' (Hunt, 1999:293). Hunt (1999) explains that the contextual factors such as the political structure and development levels, varied too sharply in both contexts. The option to allow for exemptions, or the tightening or relaxation of requirements and deadlines, provide greater flexibility in the implementation and may increase acceptance levels of the EPI. Further, constant change, such as the adoption of new policies or changing incentives of the economic agents necessitate the option to adjust the EPI ex-post to its implementation to allow for the materialisation of desired outcomes in the long term. *Thus, the assessment of policy implementability needs to include an assessment of the adaptability of the EPI to different contexts and over time.*

Within the policy cycle each phase influences the remaining ones. As such, the policy design/ formulation which shall match the correct set of (policy) instruments with the identified problem, should detail the goals of the policy, the set of policy instruments to be used, the agency responsible for implementation, possible timetables and the targeted population (PSU, 2008). However, this objective is often impeded by the necessity of increasing the feasibility and acceptability of the EPI – the accommodation of multiple interests of stakeholders results in diluted policy details in the policy formulation stage which results in vague legislative texts, which again aggravate the "correct" implementation of the policy (instrument). The "vague" legislative text, which lacks necessary details for a successful implementation, gives the administrative agency or organisation more discretion for the implementation of the policy (Theodoulou and Kofinis, 2004: 171 in PL SC). The shortcomings in this policy phase cannot be made up by the implementation by the executive administrative agencies or organisations while "interpreting" vague legislations (PL

SC). However, Gregor and Winstanly (2006) find great value in involving communities which are expected to implement the formulated and designed policies or plans, as it will reduce the possible scenario in which these policies or plans cannot or will not be implemented or will result in unintentional and undesirable side effects. For example, the opposition of the business community to effluent fees due to fears of higher costs during the 1970s in the US (Buchanan and Tullock, 1975; Sutton, 1999) highlights that communication and stakeholder participation are essential requirements in policy implementation. *These aspects necessitate the analysis of the involvement of stakeholders in the policy design and implementation during the policy cycle.*

During the policy implementation phase specific government agencies and departments are made responsible for the implementation of the *adopted* policy. As administrative agencies carry out most of the daily work of the government they have an immediate impact on the implementation of policies and on the daily lives of citizens (Anderson, 1990 in PSU, 2008). The implementation of policies may necessitate organizational reform, "as new tasks are developed, new procedures will be created, responsibilities will shift, some divisions and departments will gain importance, while others may be abolished and new patterns of internal resource allocation will emerge in accordance with the demands of new policies" (Crosby, 1996 in Sutton, 1999). Fitting new policy goals into the old public sector organizations can be promoted by establishing cross-cutting task force promoting the reform agenda (Crosby, 1996). The administrative agencies, or the newly created organisations, translate laws into operational rules and legislations – a process in which they enjoy a high degree of discretion (PSU, 2008). *This aspect necessitates the analysis of the cooperation and coordination between the institutional levels, i.e. between Ministries, the national, regional and local government representatives as well as the executing agency with the affected economic agents.*

Smith (1973: 205) identifies a further dimension which "can influence or be influenced by policy implementation", namely environmental or external factors. These factors include cultural, social, political and economic conditions into which the policy shall be introduced. These factors can be specific to certain locations or be influential on a regional level. European or national sectoral policies, such as the Common Agricultural Policy (CAP) or the Water Framework Directive (WFD) can be seen as major external factors which may influence the implementation of EPIs in a positive (synergies) or negative (barriers) way. Further, external forces, such as climatic conditions in the area in which the EPI should be implemented pay a major role in the success of its implementation. As such, markets for tradable water rights function best in water scarce areas – a precondition in which the incentive to trade water can be developed by the economic agents (Donoso, 2011). Further, external factors, such as the potential for illegal imports of products may distort the implementability of EPIs which try to reduce the use of these products by introducing higher taxes. This was the case, for example, with the Danish pesticide tax (Pedersen et al, 2011). Besides given geographical and economic factors, as the ones mentioned above, procedures and the sequence of procedures may also impact the implementability considerably. In the case of the nutrient trading program which was introduced in the Great Miami River Watershed (Ohio, USA), the lack of numeric nutrient standards posed a severe constraint to the successful implementation (and active trading)(Kieser and McCarthy, 2011). Further, the lack of an obligation to use the water acquired in the Chilean water markets led to speculation and impeded the desired outcome of the water markets and thus its successful implementation (Donoso, 2011). *These aspects necessitate the assessment of external factors which may have positive, negative or neutral impacts on policy implementability of an EPI.*

7.3 Assessment Methods and Techniques

Bearing in mind that the academic and grey literature are not specific in the application of practical definitions for the evaluation of the implementability of economic policy instruments[24], this assessment section introduces relevant sub-criteria and information requirements that are important to consider. However, these criteria are not intended to be comprehensive. The guiding questions have been updated, following the review of the application of the assessment criteria in 30 case studies.

In order to assess the level of policy implementability, three major themes are analysed, namely:

1. The adaptability of the EPI: To what extent was the EPI a flexible instrument which could be adapted to local particularities (ex-ante) and to changing conditions over time (ex-post)?

2. The implementation process: In how far was the public involved in the implementation process (public participation) and to what extent did dominant stakeholder groups influence the outcome? Did the (lack of) cooperation between institutional levels (e.g. between Ministries or between the executing agency and the economic agents) influence the policy implementability?

3. The external factors to the EPI: Did (existing) sectoral policies create synergies or barriers to the implementation of the EPI? Did climatic or procedural factors influence the implementation?

To homogenize the analyses of the case studies as far as possible and to put theory into practice, guiding questions were offered to the analysts to better assess these three major themes. The questions are listed below:

1. **The adaptability of the EPI:**
    a. Is there a mechanism that allows adjusting the instrument to local conditions? Has it been used?

[24] For example, FAO, 2003

b. Can the EPI be adjusted/ has it been adjusted following a post-implementation review (i.e. annual mandated review; review of the EPI implementation after predefined time period) or when conditions change to those which are expected today? If so, at which cost?
c. Were exemptions made/ objectives or requirements tightened or relaxed/ deadlines extended to match these local particularities – did these exemptions impede the functioning of the EPI?

2. **The implementation process I (Public involvement):**

    a. Did public participation[25] play an important role in the choice, design, implementation and operation of the EPI? Please describe the type of public participation and its contribution to the implementation of the EPI.
    b. Was the EPI in line with broadly held societal values and accepted by relevant stakeholders?
        i. Acceptance of EPI itself
        ii. Acceptance as alternative to regulation
        iii. Are there regional/ sectoral differences in the acceptance?
        iv. Are there national/ regional experiences with market-based instruments?
        v. Is the EPI in line with the economic behaviour of the targeted audience? I.e. are price changes only used for profit-maximizers?
    b. Did champions or pilot projects increase public acceptance and the EPIs implementability?
    c. Were there powerful stakeholder groups with dominant opinions which influenced the design or implementation of the EPI? Was the EPI marketed towards particular stakeholder groups, e.g. the revenues of the EPI should be used to benefit agricultural practices?
    c. Taking the results of the task on distributional effects and social equity into account, did the EPI's safeguarding mechanisms (to avoid/compensate for negative side effects/ negative distributional effects) increase the implementability?

3. **The implementation process II (institutional level):**

    a. Did cooperation and coordination between the institutions take place, i.e. between the Ministries, between national and regional governmental institutions, and/ or between the executive agency and the economic agents? If so, did this improve the implementability?

[25] By public participation, we understand the definition employed in Article 14 of the WFD which requires Member States to encourage the active involvement of all interested parties in its implementation. For further information, including definition, on public participation please have a look to the guidance developed under this topic for the practical implementation of article 14 of the WFD:
http://www.eau2015-rhin-meuse.fr/fr/ressources/documents/guide_participation-public.pdf

Were the institutional, financial and organisational structures adapted in response to the EPI implementation?

b. Were there any budgetary constraints identified during the choice/design/implementation/operation of the EPI? If that was the case, how were these treated in the EPIs design/implementation? Were there any other alternative EPIs not explicitly considered because of budgetary constraints? 26

4. **The external factors to the EPI:**

a. Can synergies between the EPI and sectoral policies be identified and taken advantage of to fulfil the objective of the EPI? On the contrary, were there any barriers linked to other policies that posed problems to the successful implementation of the EPI? 27 Possible (EU) sectoral policies include: Water Framework Directive (WFD), EU Flood Risk Management Directive (FRMD), Common Agricultural Policy (CAP), EU Energy Policy, EU Climate Change, Adaptation and Mitigation Policies, EU Nature Conservation Policies (e.g. Natura 2000).

b. Did external drivers, such as water scarcity for water markets or illegal pesticide imports following a national pesticide tax, impact the implantation of the EPI?

c. Did (the lack of) procedural factors, such as the existence of numeric nutrient standards for water quality trading impact the EPI implementation?

d. Did the (lack of) adherence to a certain sequence of implementation steps impact the implementation of the EPI, e.g. over-allocation within river basins needs to be reduced before markets in tradable water rights are implemented to achieved the desired effect

To assess the policy synergies and barriers to the EPI implementation (#4a) in a structured manner and to thus increase transparency, we suggest the use of the following table:

EPI Policy Objective: : Please specify		
Sectoral policies (examples below)	Objectives of sectoral policies	Synergies and Barriers

[26] Please note that by budgetary constraints we understand public (relevant authorities) budgets and not issues of affordability by water users.

[27] Please note: the focus lies on the impact sectoral policies had on the implementation and operation of the EPI, not vice versa

Common Agricultural Policy		++ (short text explaining score)
EU Energy policy		0 (short text explaining score)
EU Nature Conservation Policies		- (short text explaining score)
Others...		

Notes: + represents a positive synergy between the objectives of the EPI and the other policy; 3 levels: + (low positive interaction),++ (medium),+++ (high positive interaction)

0 represents no discernible interaction

- represents a negative effect between the objectives of the EPI and the other policy; 3 levels: - (low negative interaction),-- (medium),--- (high negative interaction)

This matrix shall illustrate and evaluate the interaction between the objectives of the EPI (through its many delivery mechanisms) with the main objectives of other relevant policies (EU-level and national).

7.4 Indicators

Due to the case specific nature of the assessment of policy implementability, no general indicators shall be used for its assessment. Please consult the prior section on assessment methods and techniques for the assessment methodology.

7.5 Demonstration example

Several demonstration examples on how to assess policy implementability can be found in the case studies which have been assessed as part of this project.

However, to illustrate a concrete example on the application of the assessment framework for policy implementability, please find the completed table on the synergies and barriers of sectoral policies to the EPI implementation.

Table0.1 illustrates the synergies and barriers between the SchALVO and MEKA programs (3rd column) and the water abstraction charge (4th column) in the federal state of Baden-Württemberg (Germany) and main relevant sectoral policies.

Table0.1 Synergies and Barriers between sectoral policies and the EPIs in Baden-Württemberg

		SchALVO and MEKA	Water abstraction charge (WAC)
EPI Policy Objective		Decrease nitrate concentrations in groundwater levels	Control water abstraction
Other sectoral policies	**Objectives of sectoral policies**	**Synergies and Barriers**	
Water Framework Directive (→WHG)	Ensure good ecological, chemical and quantitative status of water bodies in Germany	++ Measures and incentives to reduce agricultural diffuse sources of pollution	++ For some sectors (energy), the water abstraction charge follows the same overall objective as the WFD and introduces internalisation of environmental and resource costs of Art 9 of the WFD
CAP (→MEPL) Pillar I	Market and income support measures to provide farmers with a reasonable standard of living and consumers with quality food at fair prices.	 Single farm payments (SPS) not linked with good env. farm practices lead to a boost in agricultural production and further release of nutrients into water bodies	0 Agriculture is exempted to pay for water abstractions.
Nitrates Directive (→WHG)	Reduction and prevention of water pollution caused or induced by nitrates from agricultural sources. Sets threshold of 50 mg N/l to groundwater bodies.	++ Same objectives as SchALVO and MEKA	0
Atomic Energy Act (AtomG) and Renewable Energy Directive (→EEG)	Phase out of nuclear energy production in Germany and promotion of renewable energy technologies	-- Resultant market incentives may override incentives of compensation payments and lead to increased/ intensified production of biomass with consequent nutrient and pesticide run-off	-- Resultant market incentives may override incentives from WAC and decrease their effectiveness or acceptance respectively It may encourage further water use by renewable energy sector if abstraction charges not set correctly. Only the charge for effluents which do not fulfil WFD standards are covered by the EEG
Birds and Habitats Directive (Natura 2000)	Protection of biodiversity - increased protection of aquatic areas which are of particular ecological interest Restriction of land use and land development, including agriculture, renewable energy etc.	++ Natura 2000 provides an additional justification of why the SchALVO and MEKA programs follow relevant objectives and may cover restrictions introduced by the programs.	++ Natura 2000 provides an additional basis upon which WAC can be justified

Source: Möller-Gulland and Lago (2011)

Notes: + represents a positive synergy between the objectives of the EPI and the other policy; 2 levels:

+ (low positive interaction),++ (high positive interaction)

0 represents no discernible interaction

- represents a negative effect between the objectives of the EPI and the other policy; 2 levels:

- (low negative interaction),-- (high negative interaction)

→ means "transposed via ... German legislation". Please note that this analysis only covers the most relevant policies and is not extensive.

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8. Transaction Costs

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8.1 Introduction

Transaction costs (TCs) are often ignored in neoclassical economics; they represent market friction: the time and money cost of getting to the market, finding a buyer or seller, negotiating a purchase, consummating the trade, and returning from the market to consume the good. TCs deflect behavior from the perfect information scenario; they can explain the gap between predicted and observed outcomes. TCs affect direct costs and benefits, but participants in trades (or other activities) take them into consideration when taking actions to maximize the difference between total benefits and costs (direct and indirect, cash and non-cash).

This calculus means that some TCs are worth paying. The TC from monitoring groundwater may impede the adoption of such a tax, but it may also be worth paying to make sure the tax is effective. Likewise, a new water allocation mechanism may increase economic efficiency but impose high negotiation and enforcement costs, making simpler allocation mechanisms potentially preferable. The goal is to calculate and minimize TCs without negatively impacting the equity-efficiency tradeoff (Crals and Vereek, 2005).

Krutilla and Krause (2010) examine "TCs related to the creation, implementation and operation of environmental policies." Their analysis refers to ex-ante TCs (e.g., negotiating new property rights) and ex-post TCs (e.g., monitoring costs). They also refer to "factors affecting the magnitude of TCs" such as cultural norms, the state of technology, etc. We examine these exogenous factors under institutions.

We use Krutilla and Krause's classification of ex-ante and ex-post TCs. It's also convenient to see these as fixed and variable costs, respectively. With these differences in hand, we can look at the fixed ex-ante costs of establishing an EPI and the variable, ex-post costs of using it. As noted just above, other costs affecting EPIs that affect any and all methods of managing water (such as corruption) would be accounted for under institutions.

We identify TCs (using time or money indicators) by examining the "flow" of the EPI, from design and implementation (ex-ante) to monitoring and enforcement (ex-post). These costs can then be compared to environmental and economic benefits and costs, which can be directly attributed to the existence and operation of the EPI. A tax on groundwater extractions, for example, creates economic benefits from revenue and environmental benefits from improved groundwater levels; these benefits come

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with transaction costs for establishing a monitoring system, collecting taxes, and penalizing users for non-payment. The incidence of TCs is covered in Section 4. Institutions affect the magnitude and form of TCs, which are identified according to their effects, burdens and political impacts under policy implementation.

TCs include the costs of reducing or ignoring asymmetric information: greater expenditure on monitoring can reduce asymmetric information, but asymmetric information can also increase the TCs from implementing or using the EPI. These TCs will be explicitly included here, but Section 8 (uncertainty) will explore how the range of TCs (and other criteria) may expands with unanticipated inputs, outputs or changes in ambient policy and environmental conditions.

Past treatments of TCs

Economists mostly ignored transaction costs until 1937, when Ronald Coase explained that transaction costs determined the boundary between a firm and the market, in the sense of determining which tasks were executed within the firm (using a non-market bureaucratic process) or outsourced to the market. Coase (1960) further developed this research when he considered the case of a missing markets for externalities (pollution) produced in the course of market or non-market actions (operating a car or mowing one's lawn, for example). He claimed it would be possible to achieve efficient outcomes (relative to regulation) through the use of property rights, i.e., when either the polluter or pollutee has the right to pollute (or not be polluted). This claim included the assumption of zero TCs, i.e., both sides can negotiate without worrying about the TCs of establishing harm and benefits and negotiating their division. As a corollary to this claim, Coase noted that non-trivial TCs could impede progress towards an efficient outcome. In such a circumstance, the continued absence of a market would recommend regulation of the polluting behaviour.

From this beginning came a vast research exploring different types of TCs, their incidence, application to different situations, and so on. Williamson (1975) put TCs into a larger context of institutions: TCs affect the implementation, enforcement and effectiveness of trades, with implementation as an ex-ante TC and effectiveness and enforcement as ex-post TCs. Note that a reduction in ex-post TCs for *other* actions following the introduction of an EPI, for example, would be considered an institutional benefit from that EPI, not a TC. Moreover, the evaluation of changes in transaction costs associated with an EPI that augments or replaces a previously existing instrument must consider all costs (Langlois, 2006). Higher TCs associated with a new instrument, for example, may be small relative to the benefits of that EPI in comparison to the counterfactual.

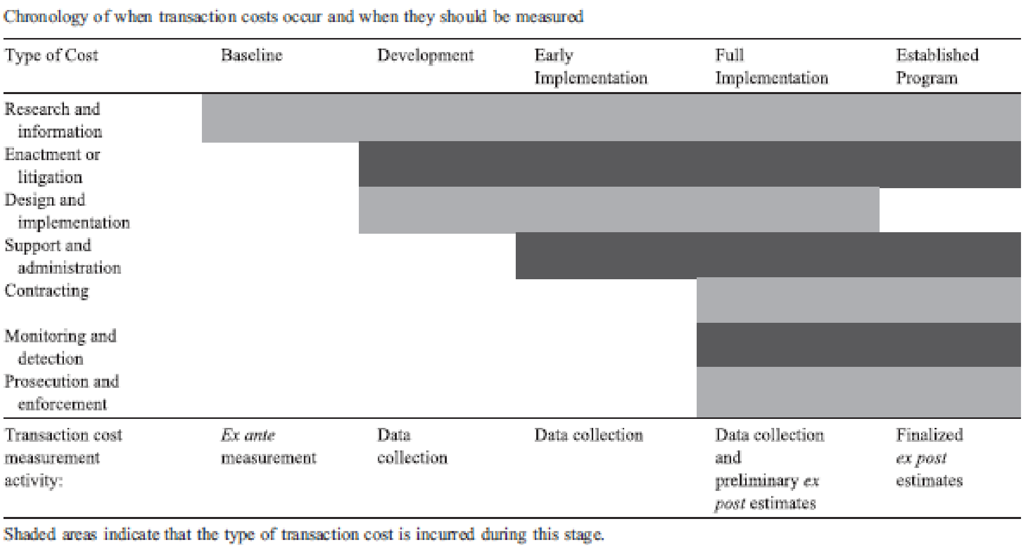
Saleth and Dinar (2004) put TCs into a water context. They discuss TCs as the time, effort and expense involved in obtaining the information required to negotiate, make and enforce an exchange. Saleth and Dinar note that TCs are sensitive to the cost of measuring valuable attributes under negotiation, market size, the need for monitoring and enforcement, and ideology. Ideology can be quite important, and it introduces political and social factors that may drive or dominate markets. As discussed under institutions, ideology comes from deep foundations that cannot easily be changed. Institutions that raise or lower transaction costs create a bias for or against certain actions. In similar work, McCann and Easter (2004) discuss the TCs of establishing a trading framework. These ex-ante fixed costs (which can include the costs of gathering information, ideology, negotiating with stake holders, etc.) can be large relative to the costs of trading once the framework is established. More important, they are often unique and thus difficult to predict or qualify in advance of taking the first step to establishing a market (or replacing any existing policy with an EPI subject to unknown unknowns). Risk-averse policymakers may prefer to avoid such uncertainty in favour of the "known evil" of an existing policy. Realistic and credible simulations that clarify the benefits of an EPI may persuade policy makers to work for reform. ACG (2006) divided TCs into *setup costs* (incurred by government and mostly fixed) such as the development of registers and water accounting frameworks; *ongoing costs* (incurred by trade participants) in effecting market transactions; and *cost of changing* the institutional environment and legal system (borne by government). According to Hardy and Koontz (2010) transaction costs include information costs (associated with the processes of gathering and organizing information necessary for group decision-making and actions), coordination costs (incurred to negotiate, monitor, and enforce agreements) and strategic costs (costs of interactions among actors, especially protecting one's interests from being dominated by others in the development of agreements or management plans).

TCs also appear in literature examining water management, as an important, but peripheral factor affecting efficiency. Howe et al. (1990) investigated the impact of TCs on facilitating or blocking water transfers. Lund (1993) discusses the timing of TCs in decisions to pursue water transfers instead of traditional "solutions" to scarcity (tapping groundwater, recycling or desalinating water). He concludes [p. 3103] that "water transfers become more attractive to potential water purchasers if the probability of a successful transfer is increased, if more of the transaction costs for water transfers are incurred after a transfer has been approved, and if the costs of delaying implementation of alternative water supplies are small." Smith and Tomasi (1995) investigate the implications of Coase (1960) on nonpoint source pollution (NPSP) from agricultural tail water. After dismissing the unrealistic case of a zero TCs world where nonpoint polluters and pollutees reach an efficient equilibrium, they compare the efficiency of taxes and standards (regulations). The conclusion is that the most-efficient response to NPSP in a second best world of TCs can include taxes, standards or both. Thompson (1999) explores NPSP and trade-offs with an emphasis on resulting errors in cost-benefit calculations. Archibald and Renwick (1998) explore the TCs and institutional barriers to water trades in California, explaining why the rosy forecasts of Vaux and Howitt (1984) failed to materialize. Both van Huylembroeck et al., (2005) and Mettepenningen et al. (2007) provide a useful description of the transaction costs farmers face in considering participation in and joining agro-environmental schemes (AES), a scenario that's directly applicable to the use of EPIs. Viaggi (2008) describes TCs related to information, monitoring and penalties in the design and implementation of contracts for agri-environmental schemes. Zhang et al. (2009) identify and analyze the transaction costs involved in the implementation of a water market in the Heihe River Basin in China. The aims of this project were to establish a new water use rights system with tradable water quotas and to reallocate and use water resources through market-based instruments. Their assessment showed that TCs blocked water trading in some areas but were low enough to allow trading in other areas. More recently, Ribaudo and Gottlieb (2011) discuss how water quality trading between point and nonpoint sources can be used for achieving water quality goals. They identify high TCs (finding trading partners) as one impediment to successful trading. They propose clearinghouses or third-party aggregators to reduce TCs.

There are thousands of scholarly article describing TCs, so we will stop here with the knowledge that it's important and useful to understand the presence and impact of TCs. Our objective is to identify TCs and quantify their impact on EPIs and alternative to EPIs. These costs are often relevant; sometimes their magnitude or incidence is enough to block the adoption or use of an EPI.

8.2 Typology

Transaction costs vary in their details. EPI-WATER case studies will list significant quantitative and qualitative TCs. An EPI will have many TCs. These will be identified and weighed according to their impact on the creation and implementation of the EPI. Figure B-3 illustrates the appearance and sequential interaction of TCs:



Source: McCann et al., 2005.

Figure B-3. Schematic example of when TCs affecting EPIs may occur

The existence of visible TCs sometimes leads to incorrect valuations of EPIs that create invisible environmental and/or economic benefits. Water trading, for example, has visible TCs, a socially-neutral exchange of cash, and invisible benefits from the net increase in surplus from the change of use. The allocation of transaction costs

Transation Costs

between different actors (e.g., public and private) is important, especially when costs go to one group and benefits to another. These costs may also be hard to identify (invisible to individuals but substantial to society) if costs and/or benefits are spread across many or concentrated in a few. Uncertainties (and information asymmetries) can magnify the visible/invisible problem - also known as the problem of visible losers and invisible winners – to the extent that policy makers contemplating the adoption of EPIs mistakenly favour the status quo.

TCs can be quantified in cash (fees) or time (days) but these measures underestimate the cost to those paying time and money, i.e., opportunity costs of the TCs as well as lost surplus from transactions that do not occur.

Krutilla and Krause (2010) note that the level of TCs are influenced by information, technology, physical/environmental characteristics (asset specificity), economic and institutional context, cultural norms, and international environmental policy-making. Imperfect information raises TCs by necessitating assessment of policy consequences, and by creating the need for ex post monitoring of compliance. TCs vary over time due to the creation and evolution of relationships and learning through repetition.

Laurenceau, et al. (2009 p. 570) suggest investigating the following sources of TCs:

- the number and roles of actors involved;
- the time spent (on selecting measures);
- the existence of decision-support tools (i.e. models);
- the methods and methodology used;
- the distinction made between basic and supplementary measures;
- administrative procedures required to carry out the selection of measures;
- the documents/guidance provided;
- coordination that was required;
- number of studies undertaken/outsourced;
- potential staff hired; and
- number of meetings, discussions, negotiations.

8.3 Assessment methods and techniques

From the discussion above, it’s clear that TCs can take many forms, affecting different parties at different times. Such variability can be confusing to someone seeking a comprehensive and balanced list and quantification of TCs.

This complication can be resolved by tracing the steps involved in implementing and using an EPI and looking for TCs at each of these steps. These calculations should be compared to a “friction free” counterfactual EPI to understand how a theoretically-optimal results may not materialize. They can also be compared to a counterfactual (but real) baseline regulatory regime to explore the costs and benefits of each alternative.

Once steps are laid out, it takes time to fill in the TCs. McCann et al. (2005) discuss the difficulties of measuring TCs that are diffuse/invisible in incidence or only qualitative. The distinction between private and public TCs is important (Libecap 2008). Public TCs require documentation about personnel assigned to specific tasks, internal budget, etc., but these costs need to be "marginalized," i.e., what are the additional TCs from an EPI on a public bureaucracy that already has full time employees who may not be completely active? Private TCs are harder to identify, since they are more diffused.

Stakeholders are obvious authorities on the types and magnitude of TCs. Interviews of participants can be useful but they take effort: TCs are difficult to explain; small compared to other costs, and mixed in with other costs (and TCs from other policies; Mettepenningen et al. (2007), had to collect information about full compliance costs to agri-environmental schemes to properly identify TCs). It's easy to make large mistakes in assessing their value.

8.4 Possible or suggested indicators

Appropriate indicators will be identified for each case study using the McCann et al. (2005) chronology and Krutilla and Krause (2010) typology.

For EPIs addressing water quality, possible indicators include the cost of installing measurement instruments (or taking a mobile measurement), the time it takes to make a measurement and report its results, the number of authorities involved in collecting and disseminating data, the time it takes to compare measurements against local or regional benchmarks, the process of enforcing penalties against violations, the cost of penalties to participants and process of clearing a penalty, and so on.

It's clear from this example that TCs will depend on the EPI, local conditions, institutions, and other factors. Case study authors will identify appropriate TCs using their judgement, literature and indicators. Some indicators will be proxies for TCs (e.g., cost of a full time employee instead of actual hours spent on a case). In most cases, it will be difficult to exactly identify or quantify TCs, but it's more important to use the same (imperfect) process to compare TCs from an EPI to TCs for the status quo counterfactual (regulation, another EPI or lack of any constraint on use of the water). For best results, it makes sense to trace TCs for each state of the design, implementation and operation of the EPI. TCs in the first two steps will mostly be fixed (time spent establishing a monitoring office, for example), while most TCs related to the operation of the EPI will be variable (e.g., monthly reporting and payments). It may be useful to compare the EPI to a counterfactual (another EPI or regulatory program) to – by comparison – how TCs vary in existence, location and magnitude.

8.5 Demonstration Example

The TCs for groundwater taxes and fees in the Netherlands fall into ex-ante cost of negotiating the 1994 national groundwater tax and the ex-post monitoring and collection of taxes. Given the lawful nature of Dutch people (an institutional characteristic), these costs are quite low – perhaps negligible. More interesting is the absence of TCs from measuring groundwater levels. Since the tax is aimed at fiscal revenues (not behavioural change), there is no monitoring of irrigation activities, flood prevention, etc. The resulting absence of TCs (good) is paired with an absence of measured benefits, if any (bad). These relatively small TCs are probably proportionate to relatively small benefits. This EPI is not aimed at changing behavior but "greening" the tax profile of the Netherlands. Its benefits are supposed to come from improved incentives to work based on lower income tax rates – not improved groundwater management or environmental health (there may be accidental benefits since industrial and drinking water extractions are taxed, but most farmers are exempt from the tax).

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9. Uncertainty

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9.1 Introduction

"Uncertainty" has a wide variety of interpretations and usage, overlapping to some extent: lack of knowledge, knowingly incurred imprecision, measurement inaccuracy, limited faculty to know, lack of confidence, inconsistency and arbitrariness of action, ambiguity and vagueness. Some of them reflect practical limitations to gathering, collating or using knowledge, others make it difficult to communicate information, and all potentially hinder the public acceptance of claims to knowledge.

Recent emphasis on uncertainty in environmental policy making reflects numerous changes in environmental science and policy making over the past few decades. First, environmental policy problems increasingly involve large, interconnected and complex social choices. For example, climate change, ozone depletion, biodiversity loss, genetically engineered crops, environment-related diseases and health risks involve large scale, long-term impacts, whose precise causes and consequences are often poorly understood. Given these uncertainties and the risk of irreversible environmental changes, different perspectives about the nature, policy implications, or even the existence of a problem are inevitable (Rittel & Webber 1973; Ackoff 1979; Rosness 1998; Sarewitz 2004).

Secondly, as a consequence, environmental policies[28] have shifted to more precautionary (Dorman 2005; Dupuy & Grinbaum 2005; Tallacchini 2005; van Asselt & Vos 2005; Vineis 2005), non-structural (Hooper & Duggin 1996; Faisal *et al.* 1999; Sabino *et al.* 1999; de Loe & Wojtanowski 2001; Lu *et al.* 2001) and demand-led approaches (de Santa Olalla Manas *et al.* 1999; Mohamed & Savenije 2000; Froukh 2001; Gumbo *et al.* 2004).

Thirdly, and also as a consequence of these new environmental problems, the process of policy making has increasingly favoured interdisciplinary, pluralistic, and inclusive methodologies (Tacconi 1998; Meppem 2000; van den Bergh et al. 2000; Shi 2004), with scientists participating alongside other stakeholders in deliberative decision making (Baber 2004; Davies & Burgess 2004; Renn 2006), participatory assessment (Kouplevatskaya-Yunusova & Buttoud; Argent & Grayson 2003; Cramb *et al.* 2004) or group model building (Vennix 1999; Sterman 2002; Stirling 2006).

[28] Relevant examples in the EU include the Sixth Environment Action Programme (EAP); Pollutant Emission Register; Regulatory framework for the Registration, Evaluation and Authorisation of Chemicals (REACH); Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances called also Seveso II Directive; proposal of EU Framework for Community Action in the field of Marine Environmental Policy (Marine Strategy Directive); Strategy for Sustainable Development; Water Framework Directive.

Environmental policy-making has to proceed in spite of uncertainties. Scientific uncertainties may be underplayed or overplayed for political advantage; used as an argument to compel or postpone policy action. For example, the perceived partiality of the Bush administration and the U.S. government in handling uncertainty of climate change prompted allegations of politicization of science. It is wrong however to dismiss all environmental policy disputes in which uncertainty is a major concern as attempts to politicize science. Uncertainty in policy making arises because of choice and subjectivity in problem formulation; discussion, contention and consensus building among interest groups; multiple and conflicting criteria; and political and social influences on priorities and policy. "In contested domains, scientists will be attacked both for not acknowledging the full range of uncertainties and for cautiously overstating uncertainties" (Shackley & Wynne 1996).

In 2007, the U.S. Supreme Court ruled out that the U.S. Environmental Protection Agency (EPA) erred to decline requests to regulate greenhouse emissions from motor vehicles under the mandate given by the Clean Air Act (Nash 2008). The EPA justified its reluctance to regulate emissions by pointing to "substantial scientific uncertainty" about the effects of climate change on human health and the environment, and about the best means to address the issue. The 1970 Clean Air Act authorizes EPA to set vehicular emission standards for substances that could reasonably be anticipated to endanger public health or welfare. The EPA released standards for smog and other pollutants, but not emissions of greenhouse gases including carbon dioxide. Relying on the report of the National Research Council (NRC 2001), the agency acknowledged scientific consensus on climate change but pointed to poor understanding of its health consequences.

9.2 Typology

Different definitions and classifications have been proposed to convey the diversity of meanings of uncertainty and to provide guidance in assessing and communicating it. The definitions proposed are vague, and arguably a satisfactorily broad and unambiguous definition of uncertainty is precluded by this diversity. Some authors approach a definition through the context requiring it. According to Pielke and Rayner (2004), uncertainty means in general that a problem has multiple possible interpretations, multiple possible outcomes or that one outcome can be reached through multiple alternative pathways (equifinality). Zimmermann (2000) is more specific about products afflicted with uncertainty, attributing to uncertainty a "situation (in which) a person does not dispose about information which quantitatively or qualitatively is appropriate to describe, prescribe or predict deterministically and numerically a system, its behaviour or other characteristics". This merely shifts the problem to defining "appropriate" and seems to suppose, wrongly, that one cannot usefully describe or predict with uncertainty. Brashers (2001) on the other hand presents a definition with respect to the reasons for which we are uncertain: "Uncertainty exists when details of situations are ambiguous, complex, unpredictable or probabilistic; when information is unavailable or inconsistent; and when people feel insecure in their own state of knowledge or the state of knowledge in general". In our view this focus on the frame of mind of the person confronted with uncertainty is helpful, as it permits application of a notion of uncertainty to the perceptual and judgemental aspects of the information-gathering and information-using process leading to policy.

Numerous typologies and techniques have been developed to conceptualise, classify, assess (qualitatively and quantitatively), propagate, control, reduce and communicate uncertainty. Various classification schemes for uncertainty have been developed that extend explicit definitions while maintaining a degree of generality. The existing typologies differ in scope (for example uncertainty in modelling versus uncertainty in decision making) and purpose. It has been proposed (Walker *et al.* 2003) that one should categorise the nature or roots of uncertainty (reducible vs irreducible, epistemic vs ontological), location (context, model, inputs, parameters, outputs), and level (statistical uncertainty, scenario uncertainty, recognised ignorance, unrecognised ignorance). The problem with this and other typologies is that their authors are primarily concerned with resolving apparent inconsistencies and lack of detail in terms and meanings ascribed to different concepts of uncertainty. In other words, a "top down" view is taken. A consequence is that it is easy to overlook very specific aspects, sources or types of uncertainty that are particular to their context yet demand effective handling. As for models, typologies of uncertainty are abstractions that are useful only as far as they are responsive to specific situations and helpful as tools to address them (Norton *et al.* 2006).

Kandlikar *et al.* (2005) proposed an useful way how to characterise the magnitude of uncertainty. Ideally, a full probability distribution can be determined either numerically or through a formal quantitative survey of expert views. In other situations, a likelihood or probability of occurrence can be determined for an event or for representative outcomes, e.g. based on multiple observations, model ensemble runs, or expert judgment. Is this information not available, it may at least be possible to determine a range (e.g. upper and lower bounds or as 5th and 95th percentiles) of a variable. Finally, the least accurate information can be expressed through the order of magnitude or the direction of change (increase, decrease, no significant change).

Uncertainty is pervasive to **all dimensions of assessment framework** but in many different ways. *Environmental benefits* of EPIs, their *costs* and *distributional effects* (at least to some extent) can be characterised quantitatively and are usually combined in an aggregate measure of cost-benefit, cost-effectiveness or there like. Uncertainty arises because of the effects and costs of the economic policy instruments cannot be determined precisely and because the observed attainments cannot be uniquely attributed to a single policy or a portfolio of policies.

To make it clear, it is practical to distinguish between policy outputs and outcomes. Outcomes are short or long term achievements brought about by the introduced policy. Outputs on the other hand are activities or their straight achievements or milestones that anticipate or approximate the outcomes. For example, the reduced residential water consumption (demand) is an outcome of a policy such as water efficiency standards or financial incentives to increase the use of water-conserving appliances. The outputs of these policies are a number of modern water appliances sold or a number of households/dwelling units that have been built in compliance with the water-sensitive building standards. Although better traceable, the outputs are imperfect proxies of the ultimate policy outcomes. The number of water saving appliances does not give immediate information about the total volume of water saved since that depends on the dwelling or household specific use of those appliances. The imperfect knowledge about the underlying relationship between the policy outputs and the outcomes is a source of uncertainty. Furthermore, the observed attainments, in terms of outputs and even more so in terms of outcomes, may not be easily attributable to a single policy or a policy mix.

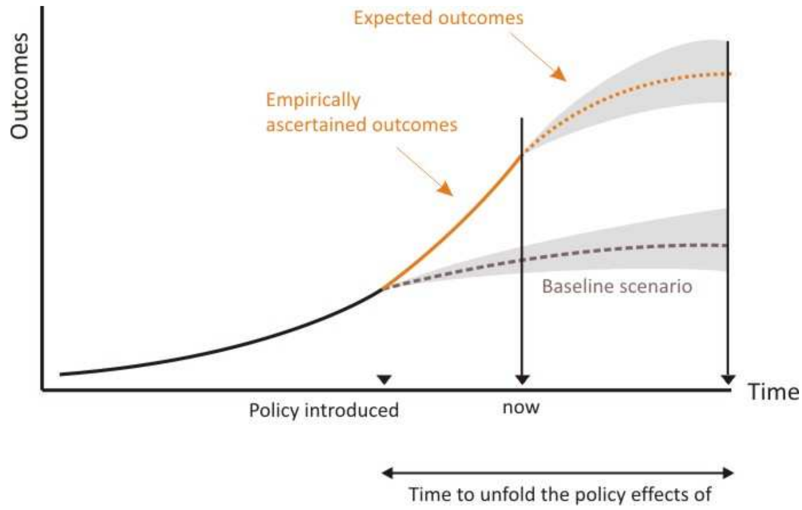

Figure B-9 Primary sources of uncertainty in the assessment of the policy attainments

Because the attained benefits and a part of the implementation and compliance costs lay in the future, at the moment of the assessment exercise these can only be approximated. Uncertainty is comprised in 1) the specification of the 'everything being equal' baseline describing the degree to which the objectives were fulfilled had no policy been introduced; 2) the empirically ascertained policy outputs/outputs realised up to the assessment date (measurement or observation imprecision or biases); and 3) projection of the policy outputs/outputs up to the date the policy effects are fully unfold (Figure B.9).

Institutional set up and other factors governing *policy implementability* and *success* are variables which shape the level of the fulfilment of the policy objectives and the costs. For the most part these criteria are qualitative and thus difficult to combine with the likelihood of the costs/benefits.

The overarching goal of sound natural resource management is an equitable, efficient and sustainable use of managed resources (e.g. water, forests, and species stocks). The governance systems put in place in democratic societies to reach this goal must respect the principles of good governance, as laid down in the EC White Paper on Governance (EC, 2001): to be transparent and accessible, inclusive, effective, coherent and accountable. Good environmental governance is both an end in itself and a mean to reach higher level environmental goals. This suggests that the ultimate policy outcomes may be measured by how closely these goals both can be, or have been achieved.

9.3 Assessment methods and technique

There is a large number of techniques for expressing, manipulating and using uncertain quantities. Such expressions range in detail from bounds, to the fuzzy-set approach, and probability distribution functions derived from observed frequencies, expert judgements or both.

For the scope of the EPI-WATER project we propose to use the pedigree analysis drawing on, or inspired by, the assessment techniques developed by van der Sluijs *et al* (2005). The pedigree represents an explicit account of the quality of information and the processes underlying the knowledge production process. In the basic form (van der Sluijs 2007), the pedigree criteria is a set of variables named *proxy* (functional relationship between the outcomes and outputs), *empirical basis*, *methodological rigor*, and *validation*. The pedigree criteria are assessed through expert judgement, using qualitative statements as in the Table B-10.

Table B-10. Pedigree criteria (van der Sluijs 2007)

Code	*Proxy*	*Empirical*	*Method*	*Validation*
4	Exact measure	Large sample direct measurements	Best available practice	Compared with indep. mmts of same variable
3	Good fit or measure	Small sample direct measurements	Reliable method commonly accepted	Compared with indep. mmts of closely related variable
2	Well correlated	Modeled/ derived data	Acceptable method limited consensus on reliability	Compared with mmts not independent
1	Weak correlation	Educated guesses / rule of thumb estimate	Preliminary methods unknown reliability	Weak / indirect validation
0	Not clearly related	Crude speculation	No discernible rigor	No validation

.

9.4 Demonstration example

Aiming to achieve better management of energy, the large-scale roll-out of smart meters is a recent major energy efficiency policy initiative in the UK (DoECC 2011). The project will involve a visit to every home and many businesses in Great Britain, and the replacement of around 53 million gas and electricity meters. The benefits of installing smart meters are that they provide consumers with near real-time information about energy use, and more accurate bills. Smart meters, together with real time in-home displays, can provide consumers with detailed information on their energy use and access to a wide range of off-peak electricity tariffs. Smart meters also allow suppliers to collect meter readings electronically, leading to more accurate energy bills and cutting costs.

Costs of delivering the smart metering system in every home and the associated communications technology is expected to reach GBP 11.3 billion. The costs will be borne by energy suppliers. The Department of Energy and Climate Change expects costs and cost savings to be passed down to costumers. Public expenditure on smart meters will be limited to the cost of programme management and consumer engagement work.

The Department expects economic benefits of the program to reach GBP 18.6 billion between 2011 and 2030, achieving a discounted net present benefit of GBP 7.3 billion.

Several uncertainties and risks of the programme have been identified by the UK National Audit Office (NAO 2011). On the one hand these concern consumer benefits, as international experiences and domestic trials together provided only limited evidence to support particular assumptions about how much and how long consumer behaviour will change. Costs may also increase more than expected, and major technical and logistical challenges may also arise. Furthermore, there is also a risk that suppliers do not pass on the net savings to their costumers.

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